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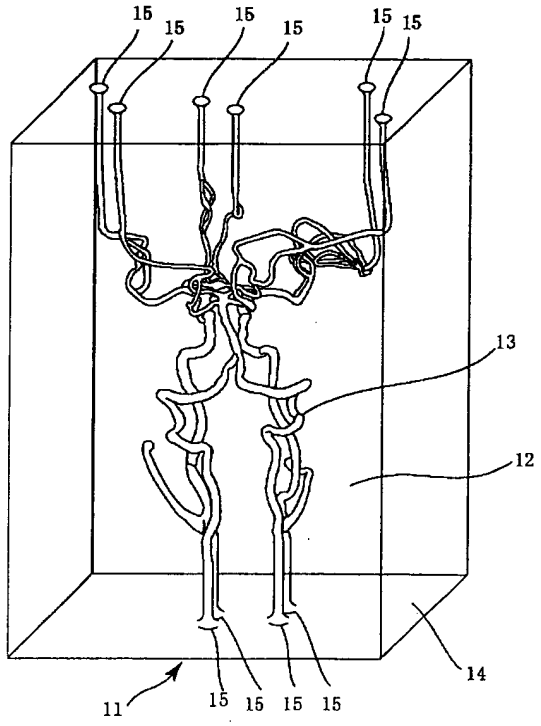
(54)【発明の名称】　内部に腔所を再現した立体モデルの製造方法及び内部に腔所を再現した立体モデル

(57)【要約】
【課題】　身体に存在する腔所を内部に再現した立体モデルを、データに基づいて製造し、製造にあたり、多様な材料の使用を可能とするとともに、立体モデルの造形体積によらず短時間での製造を可能とする。
【解決手段】　データに基づいて積層造形を行うことにより、前記腔所を再現した積層造形モデルを作製し、その周囲を成形材料で満たす。そして、成形材料を硬化させた後、前記積層造形モデルを、前記成形材料の硬化により形成された立体モデルの内部より外部へ溶出する。これによって、積層造形によって直接立体モデルの造形を行う場合と異なり、積層造形では使用が不可能である多様な材料を使用して立体モデルを製造できるとともに、造形体積によらず短時間で立体モデルを得ることができる。



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【特許請求の範囲】

【請求項１】　身体に存在する腔所を再現した積層造形モデルを溶出することによって、該積層造形モデルと同一の形状を有する空洞を形成し、これにより内部に前記腔所を再現した立体モデルを得る方法であって、(a) 腔所を再現した積層造形モデルを積層造形するためのデータを用意する準備行程と、(b) 前記積層造形モデルを、前記データを利用した積層造形を経て作製する積層造形行程と、(c) 積層造形行程で得られた前記積層造形モデルの周囲を成形材料で満たした後、該成形材料を硬化させて立体モデルを形成する形成行程と、(d) 加熱により前記積層造形モデルを溶融し、形成行程で前記成形材料の硬化を経て得られた立体モデルの外部へ溶出する溶出行程と、を備えることを特徴とする内部に腔所を再現した立体モデルの製造方法。

【請求項２】　身体に存在する腔所を再現した積層造形モデルを溶出することによって、該積層造形モデルと同一の形状を有する空洞を形成し、これにより内部に前記腔所を再現した立体モデルを得る方法であって、(a) 腔所を再現した積層造形モデルを積層造形するためのデータを用意する準備行程と、(b) 前記積層造形モデルを、前記データを利用した積層造形を経て作製する積層造形行程と、(c) 積層造形行程で得られた前記積層造形モデルの周囲を成形材料で満たした後、該成形材料を硬化させて立体モデルを形成する形成行程と、(d) 溶剤により前記積層造形モデルを溶解し、形成行程で前記成形材料の硬化を経て得られた立体モデルの外部へ溶出する溶出行程と、を備えることを特徴とする内部に腔所を再現した立体モデルの製造方法。

【請求項３】　身体に存在する腔所を再現した積層造形モデルを溶出することによって、該積層造形モデルと同一の形状を有する空洞を形成し、これにより内部に前記腔所を再現した立体モデルを得る方法であって、(a) 腔所を再現した積層造形モデルを積層造形するためのデータを用意する準備行程と、(b) 前記積層造形モデルを、前記データを利用した積層造形を経て作製する積層造形行程と、(c) 積層造形行程で得られた前記積層造形モデルの周囲を成形材料で満たした後、該成形材料を硬化させて立体モデルを形成する形成行程と、(d) 加熱による溶融と、溶剤による溶解と、を併用することによって、前記積層造形モデルを、形成行程で前記成形材料の硬化を経て得られた立体モデルの外部へ溶出する溶出行程と、を備えることを特徴とする内部に腔所を再現した立体モデルの製造方法。

【請求項４】　請求項１から請求項３のいずれかに記載の内部に腔所を再現した立体モデルの製造方法において、さらに、前記準備工程で用意する前記データを撮影装置による撮影に基づいて生成するデータ生成行程を、前記準備工程の前に備えることを特徴とする内部に腔所を再現した立体モデルの製造方法。

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【請求項５】　請求項１から請求項４のいずれかに記載の内部に腔所を再現した立体モデルの製造方法において、さらに、前記溶出行程の後の行程、或いは、前記溶出行程の途中に介在する行程として、前記溶出行程において、前記立体モデルの内部へと拡散した前記積層造形モデルの構成材料の成分を、前記立体モデルを加熱することによって蒸発させ、前記立体モデルの内部より除去する拡散除去行程を備えることを特徴とする内部に腔所を再現した立体モデルの製造方法。

【請求項６】　請求項１から請求項５のいずれかに記載の内部に腔所を再現した立体モデルの製造方法において、粉末状の造形材料上にレーザを走査することにより焼結硬化層を形成し、この焼結硬化層を順次形成すると同時に積層させていく方式の積層造形を経て、前記積層造形モデルを作製することを特徴とする内部に腔所を再現した立体モデルの製造方法。

【請求項７】　請求項１から請求項５のいずれかに記載の内部に腔所を再現した立体モデルの製造方法において、ノズルより加熱溶融した造形材料を噴出或いは滴下させ固化させながらノズルヘッドを走査させて薄層を形成し、この薄層を順次形成すると同時に積層させていく方式の積層造形を経て、前記積層造形モデルを作製することを特徴とする内部に腔所を再現した立体モデルの製造方法。

【請求項８】　請求項１から請求項５のいずれかに記載の内部に腔所を再現した立体モデルの製造方法において、ノズルより造形材料を押し出し、この細線状の造形材料を描画するようにノズルから押し出し固化させながら、ノズルヘッドを走査させることによって薄層を形成し、この薄層を順次形成すると同時に積層させていく方式の積層造形を経て、前記積層造形モデルを作製することを特徴とする内部に腔所を再現した立体モデルの製造方法。

【請求項９】　内部に腔所を再現した立体モデルであって、(a) 成形材料の硬化により形成された立体モデル形成部分と、(b) 加熱による溶融を経て積層造形モデルを溶出することにより形成された空洞部分と、を備えることを特徴とする内部に腔所を再現した立体モデル。

【請求項１０】　内部に腔所を再現した立体モデルであって、(a) 成形材料の硬化により形成された立体モデル形成部分と、(b) 溶剤による溶解を経て積層造形モデルを溶出することにより形成された空洞部分と、を備えることを特徴とする内部に腔所を再現した立体モデル。

【請求項１１】　内部に腔所を再現した立体モデルであって、(a) 成形材料の硬化により形成された立体モデル形成部分と、(b) 加熱による溶融と、溶剤による溶解とを併用して、積層造形モデルを溶出することにより形成された空洞部分と、を備えることを特徴とする内部に腔所を再現した立体モデル。

【請求項１２】　請求項９から請求項１１のいずれかに

記載の内部に腔所を再現した立体モデルであって、前記成形材料が硬化後において透明性を有することを特徴とする内部に腔所を再現した立体モデル。

【請求項１３】　請求項１２に記載の内部に腔所を再現した立体モデルであって、前記立体モデルの外部形状に少なくとも一つの平面を有することを特徴とする内部に腔所を再現した立体モデル。

【請求項１４】　請求項９から請求項１３のいずれかに記載の内部に腔所を再現した立体モデルであって、前記立体モデル形成部分の全部或いは一部に、シリコーンゴム（シリコーンエラストマー又はシリコーンゲル）が使用されていることを特徴とする内部に腔所を再現した立体モデル。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、身体に存在する腔所を内部に再現した立体モデル及びその製造方法に関し、さらに詳しくは、腔所の形状を再現した積層造形モデルを積層造形によって作製し、これを溶出して空洞を形成することによって得られる立体モデル、及びその製造方法に関する。

【０００２】

【従来の技術】現在、医療機器の分野では、Ｘ線ＣＴ装置やＭＲＩ装置、超音波装置といった各種の撮影装置が、身体の諸器官における各種の疾病、あるいは妊娠等の検査や診断の目的で普遍の技術として利用されるようになっている。

【０００３】これらの撮影装置によれば、無侵襲によって身体内部の撮影を行うことが可能であり、従来、医師らは、撮影装置によって間隔を空けて二次元撮影を行い、得られた二次元データを基に生成された複数枚の二次元画像を連続的に配置することなどによって、撮影領域の三次元形状をイメージし、手術の際に重要となる病巣や器官などとの相対位置関係を把握することを行ってきた。しかしながら、このような方法により幹部周辺の三次元構造を理解することは一般に容易ではない。

【０００４】近年登場した、ヘリカルスキャン方式のＸ線ＣＴ装置などによれば身体に対して三次元の撮影を行うことが可能であり、これによって身体内部の三次元データを直接的に得ることができる。そして、ディジタル画像処理技術などの進展に伴い、撮影装置により得られた前記二次元データや前記三次元データを基にコンピュータによる再構成を行うことによって、撮影領域の三次元画像を生成することも可能なった。さらには、生成された三次元画像に対して、任意の断面の二次元画像を生成し表示することや、視点を変更して表示することや、器官や組織毎に着色表示を行うことなどの様々な技術が開発され、それらの利用も可能となった。そして、これらの環境を利用することで、撮影によって得られる画像情報をより容易に、かつより正確に把握することが可能となり、身体内部の三次元構造を把握するための環境は飛躍的に向上した。

【０００５】しかしながら、これらの方法によって呈示される情報は、依然として従来と変わらず画像を主体としたものであり、例えば、得られたモデルを実際に手に取ってみることや、得られたモデルを使用して実際に手術を試行してみることなどは、これら方法によっては不可能である。

【０００６】現在、急速に普及しつつある積層造形は、こうした要求を満たす画期的な装置として医学界においても急速に普及しつつある。

【０００７】積層造形には光造形を始めとする様々な積層造形方式がある。この積層造形は、データに基づいて薄層を順次形成すると同時に積層させていくことによって、所望の三次元形状を有する三次元造形物を造形する技術である。この積層造形によれば、前記撮影装置によって得られた二次元画像や三次元画像を基に、対象とする部位を、同一形状を有する立体モデルとして精密に再現することが可能である。

【０００８】特開平５－１１６８９は、積層造形によるこうした立体モデルの製造方法を提案したものである。この発明は、撮影装置により等間隔に撮影することにより得られた複数枚の二次元画像を基に、積層造形の一種である光造形により積層造形を行うことによって、対象とする諸器官と同一形状を有する立体モデルを製造する方法を提供するものである。この発明によれば、痛みや人体への影響を与えることなく、低侵襲、或いは無侵襲によって、十分な画像情報が得られる限りにおいて、いかなる部位でも、その内部形状まで含めて立体モデルとして忠実に再現することが可能である。

【０００９】

【発明が解決しようとする課題】特開平５－１１６８９によってその製造方法が提案される内臓や器官類の立体モデルでは、特に対象とする部位全体の形状を精密に再現すること主眼が置かれており、身体に存在する腔所を再現することに重点が置かれている訳ではない。しかしながら、身体に存在する腔所を再現した立体モデルは、腔所の形状或いは構造の把握の他、医療機器を実際に使用しての手術試行など、様々な分野において多様な利用が可能であり、そのような立体モデルを製造することは非常に有益である。

【００１０】一方、特開平５－１１６８９のように、積層造形により立体モデルの製造を行う場合、該立体モデルの製造には、積層造形に使用する積層造形システムの特性に依存した造形材料を使用せざるを得ず、材料選択の自由度は非常に低い。そして、現状においては、例えば、高い透明性を備えた造形材料や、身体組織を再現するのに十分な柔軟性を備えた造形材料などは殆ど存在せず、よって、それらの特性を有した立体モデルを製造することは困難或いは不可能である。また、非常に薄い造

形層を積層することによって立体モデルの造形を行う積層造形では、造形に対する所要時間は、立体モデルの造形体積の増加や造形精度の向上などに伴って飛躍的に増大する。したがって、特開平５－１１６８９に提案される方法では、積層造形によって直接的に造形体積の大きな立体モデルの造形を行うような場合には立体モデルの造形に長時間を費やすことを余儀なくされる。

【００１１】このため、積層造形に使用する積層造形システムの特性に依存した造形材料以外の材料によって構成された、身体に存在する腔所を内部に再現した立体モデル、並びに、該立体モデルを、造形体積の増加や造形精度の向上などに伴って造形に対する所要時間を飛躍的に増大させることなく、製造するための製造技術を得ることが望まれる。

【００１２】

【発明の目的】本発明は、上記課題に鑑みてなされたものであり、その目的は、積層造形に使用する積層造形システムの特性に依存した造形材料以外の材料によって構成された、身体に存在する腔所を内部に再現した立体モデルと、該立体モデルを、造形体積の増加や造形精度の向上などに伴って飛躍的に造形に対する所要時間を増大させることなく、製造するための製造技術を得ることにある。

【００１３】

【用語の定義】この明細書における各用語は以下のように定義される。

【００１４】「腔所」とは、身体に存在する空所を総称する用語であり、諸器官（骨格、筋、循環器、呼吸器、消化器、泌尿生殖器、内分泌器、神経、感覚器など）に存在する空所、並びに、これらの諸器官や体壁などの幾何学的配置によって構成される空所を指す。したがって、心臓の内腔、胃の内腔、腸の内腔、子宮の内腔、血管の内腔、尿管の内腔などの諸器官の内腔や、口腔、鼻腔、口峡、中耳腔、体腔、関節腔、囲心腔などは「腔所」に含まれる。

【００１５】「積層造形モデル」とは、積層造形を経て作製された三次元造形物を指す用語であり、よって、積層造形単独によって作製された三次元造形物に限定されることなく、積層造形を含む一連の造形行程を経て作製された三次元造形物も含む。

【００１６】「立体モデル」とは、本発明によって得られる内部に腔所を再現したモデルのみを指す用語であって、この明細書の中で他の一般的な立体形状のモデルを指す場合に使用する「三次元モデル」とは区別される。したがって、積層造形によって得られるモデルなどは「三次元モデル」には含まれるが、「立体モデル」には含まれない。

【００１７】「撮影装置」とは、撮影を行うことによって、身体に存在する腔所に関するデータを取得可能な装置を総称する用語であり、各種方式のＸ線装置（Ｘ線ＣＴ装置を含む）、ＭＲＩ装置、超音波装置なども「撮影装置」に含まれる。

【００１８】「成形材料」とは、硬化し、この特性を利用して三次元造形物の成形に使用可能な材料を総称する用語である。

【課題を解決するための手段】

【００１９】上記の目的を達成するため、請求項１の発明では、身体に存在する腔所を再現した積層造形モデルを溶出することによって、該積層造形モデルと同一の形状を有する空洞を形成し、これにより内部に前記腔所を再現した立体モデルを得る方法であって、(a) 腔所を再現した積層造形モデルを積層造形するためのデータを用意する準備行程と、(b) 前記積層造形モデルを、前記データを利用した積層造形を経て作製する積層造形行程と、(c) 積層造形行程で得られた前記積層造形モデルの周囲を成形材料で満たした後、該成形材料を硬化させて立体モデルを形成する形成行程と、(d) 加熱により前記積層造形モデルを溶融し、形成行程で前記成形材料の硬化を経て得られた立体モデルの外部へ溶出する溶出行程と、を備えることを特徴とする。

【００２０】また、請求項２の発明は、身体に存在する腔所を再現した積層造形モデルを溶出することによって、該積層造形モデルと同一の形状を有する空洞を形成し、これにより内部に前記腔所を再現した立体モデルを得る方法であって、(a) 腔所を再現した積層造形モデルを積層造形するためのデータを用意する準備行程と、(b) 前記積層造形モデルを、前記データを利用した積層造形を経て作製する積層造形行程と、(c) 積層造形行程で得られた前記積層造形モデルの周囲を成形材料で満たした後、該成形材料を硬化させて立体モデルを形成する形成行程と、(d) 溶剤により前記積層造形モデルを溶解し、形成行程で前記成形材料の硬化を経て得られた立体モデルの外部へ溶出する溶出行程と、を備えることを特徴とする。

【００２１】また、請求項３の発明は、身体に存在する腔所を再現した積層造形モデルを溶出することによって、該積層造形モデルと同一の形状を有する空洞を形成し、これにより内部に前記腔所を再現した立体モデルを得る方法であって、(a) 腔所を再現した積層造形モデルを積層造形するためのデータを用意する準備行程と、(b) 前記積層造形モデルを、前記データを利用した積層造形を経て作製する積層造形行程と、(c) 積層造形行程で得られた前記積層造形モデルの周囲を成形材料で満たした後、該成形材料を硬化させて立体モデルを形成する形成行程と、(d) 加熱による溶融と、溶剤による溶解と、を併用することによって、前記積層造形モデルを、形成行程で前記成形材料の硬化を経て得られた立体モデルの外部へ溶出する溶出行程と、を備えることを特徴とする。

【００２２】請求項４の発明は、請求項１から請求項３

のいずれかに記載の内部に腔所を再現した立体モデルの製造方法において、さらに、前記準備工程で用意する前記データを撮影装置による撮影に基づいて生成するデータ生成行程を、前記準備工程の前に備えることを特徴とする。

【００２３】請求項５の発明は、請求項１から請求項４のいずれかに記載の内部に腔所を再現した立体モデルの製造方法において、さらに、前記溶出行程の後の行程、或いは、前記溶出行程の途中に介在する行程として、前記溶出行程において前記立体モデルの内部へと拡散した前記積層造形モデルの成分を、前記立体モデルを加熱することによって蒸発させ、前記立体モデルの内部より除去する拡散除去行程を備えることを特徴とする。

【００２４】請求項６の発明は、請求項１から請求項５のいずれかに記載の内部に腔所を再現した立体モデルの製造方法において、粉末状の造形材料上にレーザを走査することにより焼結硬化層を形成し、この焼結硬化層を順次形成すると同時に積層させていく方式の積層造形を経て、前記積層造形モデルを作製することを特徴とする。

【００２５】請求項７の発明は、請求項１から請求項５のいずれかに記載の内部に腔所を再現した立体モデルの製造方法において、ノズルより加熱溶融した造形材料を噴出或いは滴下させ固化させながらノズルヘッドを走査させて薄層を形成し、この薄層を順次形成すると同時に積層させていく方式の積層造形を経て、前記積層造形モデルを作製することを特徴とする。

【００２６】請求項８の発明は、請求項１から請求項５のいずれかに記載の内部に腔所を再現した立体モデルの製造方法において、ノズルより造形材料を押し出し、この細線状の造形材料を描画するようにノズルから押し出し固化させながら、ノズルヘッドを走査させることによって薄層を形成し、この薄層を順次形成すると同時に積層させていく方式の積層造形を経て、前記積層造形モデルを作製することを特徴とする。

【００２７】請求項９から請求項１４の発明は、このような製造方法により製造される内部に腔所を再現した立体モデルの利点を有している。

【００２８】このうち、請求項９の発明の内部に腔所を再現した立体モデルは、(a) 成形材料の硬化により形成された立体モデル形成部分と、(b) 加熱による溶融を経て積層造形モデルを溶出することにより形成された空洞部分と、を備えることを特徴とする。

【００２９】また、請求項１０の発明の内部に腔所を再現した立体モデルは、(a) 成形材料の硬化により形成された立体モデル形成部分と、(b) 溶剤による溶解を経て積層造形モデルを溶出することにより形成された空洞部分と、を備えることを特徴とする。

【００３０】また、請求項１１の発明の内部に腔所を再現した立体モデルは、(a) 成形材料の硬化により形成された立体モデル形成部分と、(b) 加熱による溶融と、溶剤による溶解とを併用して、積層造形モデルを溶出することにより形成された空洞部分と、を備えることを特徴とする。

【００３１】請求項１２の発明の内部に腔所を再現した立体モデルは、請求項９から請求項１１のいずれかに記載の内部に腔所を再現した立体モデルであって、前記成形材料が硬化後において透明性を有することを特徴とする。

【００３２】請求項１３の発明の内部に腔所を再現した立体モデルは、請求項１２に記載の内部に腔所を再現した立体モデルであって、前記立体モデルの外部形状に少なくとも一つの平面を有することを特徴とする。

【００３３】請求項１４の発明の内部に腔所を再現した立体モデルは、請求項９から請求項１３のいずれかに記載の内部に腔所を再現した立体モデルであって、前記立体モデル形成部分の全部或いは一部に、シリコーンゴム（シリコーンエラストマー又はシリコーンゲル）が使用されていることを特徴とする。

【００３４】

【発明の実施の形態】以下、本発明を添付図面に基づいて詳細に説明する。

【００３５】図１は、本発明の内部に腔所を再現した立体モデルの実施の一形態を示した全体斜視図、図２は、積層造形により作製された、腔所を再現した積層造形モデルの実施の一形態を示した全体斜視図、また図３は、図２に示す腔所を再現した積層造形モデルを中空の構造として作製した場合の断面構造を示す要部断面拡大斜視図である。図４から図８は、本発明の内部に腔所を再現した立体モデルの製造方法について、各製造行程をそれぞれ一つのステップとして概要を説明したフローチャートであって、図４から図８のフローチャートは、それぞれ請求項１から請求項５に記載の内部に腔所を再現した立体モデルの製造方法に対応している。尚、これらの各図において互いに共通する行程には同一のステップ番号を使用している。

【００３６】以下では、本発明の内部に腔所を再現した立体モデルの製造方法を、添付図面に基づいて詳細に説明する。

【００３７】本発明の内部に腔所を再現した立体モデルは、(a) 腔所を再現した積層造形モデルを積層造形するためのデータを用意する準備行程と、(b) 前記積層造形モデルを、前記データを利用した積層造形を経て作製する積層造形行程と、(c) 積層造形行程で得られた前記積層造形モデルの周囲を成形材料で満たした後、該成形材料を硬化させて立体モデルを形成する形成行程と、(d) 前記積層造形モデルを、形成行程で前記成形材料の硬化を経て得られた立体モデルの外部へ溶出する溶出行程と、を備えることを特徴とする製造方法により製造される。さらに、請求項４に記載の製造方法では、前記準備

工程で用意する前記データを撮影装置による撮影に基づいて生成するデータ生成工程を、前記準備工程の前に備える。また、請求項５に記載の製造方法では、前記溶出行程の後の行程、或いは、前記溶出行程の途中に介在する行程として、前記立体モデルを加熱することによって、前記溶出行程において前記立体モデルの内部へと拡散した前記積層造形モデルの構成材料の成分を蒸発させ、前記立体モデルの内部より除去する拡散除去行程を備える。

【００３８】以下では、本発明の内部に腔所を再現した立体モデルの製造に係る各製造工程を、図４から図８のフローチャートに示す各ステップと対比させながら詳細に説明する。

【００３９】＜Ａ．データ生成行程＞　請求項４に記載の内部に腔所を再現した立体モデルの製造方法は、準備工程で用意するデータ（腔所を再現した積層造形モデルを積層造形するためのデータ）を、撮影装置による撮影に基づいて生成するデータ生成工程を備えることを特徴とする。以下では、このデータ生成工程の実施形態について詳述する。このデータ生成工程は、図７及び図８に示すフローチャートのステップＳＴ０に対応する。

【００４０】準備工程で用意するデータを、撮影装置による撮影に基づいて生成するためには、まず、Ｘ線ＣＴ装置やＭＲＩ装置などの撮影装置によって、対象とする身体の二次元画像、或いは三次元画像を得る。撮影装置には、種類によって、二次元画像のみ得ることができるものと、三次元画像を得ることができるものとが存在する。前記データの生成には、前記腔所に関する三次元の画像情報が必要とされるため、二次元画像しか得られない撮影装置を使用する場合には、撮影位置を変えて撮影を行うことにより複数の二次元画像を得る必要がある。尚、撮影位置の変更は、例えば平行移動によって行えばよい。これによって等間隔、或いは任意間隔で複数の二次元画像を撮影することができ、得られた二次元画像を撮影間隔に基づいて積層することによって、前記データの生成に必要とされる三次元の画像情報が得られる。しかし撮影位置の変更は平行移動によることなく、十分な三次元の画像情報が得られる限りにおいて自由に行えばよい（任意方向への撮影位置の移動、或いは撮影方向の回転）。また、複数の撮影装置によって得られた二次元画像や三次元画像を組み合わせて利用してもよい。尚、二次元画像の撮影間隔（撮影密度）は、腔所形状の再現の精度に直結するため、必要とされる再現の精度に応じて適切に調節する必要がある。

【００４１】次に、これらの二次元画像、三次元画像の撮影に利用可能な代表的な撮影装置について説明する。但し、撮影装置には以下で説明する装置以外にも様々なものがあり、本発明はこれらの撮影装置に限定されるものではない。

【００４２】Ｘ線ＣＴ装置としては、身体の横同一断面上のあらゆる方向からＸ線による撮影を行い、得られた情報をコンピュータ処理することによって、撮影断面の二次元画像を得る従来方式のＸ線ＣＴ装置の他、対象とする身体を体軸方向に動かしながら、一方で体軸に垂直な平面内でＸ線検出機構を回転させながら撮影を行うことによって螺旋状のＸ線撮影を行い、これによって得られた身体の三次元情報をコンピュータ処理することにより、三次元画像や、任意断面での二次元画像を得ることができるヘリカルスキャン方式のＸ線ＣＴ装置などがある。さらに、ヘリカルスキャン方式のＸ線ＣＴ装置には、装置内部に多列のＸ線検出機構を内蔵することによって複数箇所の同時撮影を可能とし、これによって空間分解能の向上や撮影時間の短縮などを実現したマルチスライス方式のものも存在する。

【００４３】ＭＲＩ装置は、身体の大部分を構成する水素原子の核磁気共鳴現象を利用した装置であり、この現象が身体組織に含まれる水素原子の量と水素原子の周囲の環境の違いに影響されることに基づいて組織の状態を画像化するものである。この装置によれば、対象となる身体の位置を変えることなく任意断面の二次元画像を得ることが可能であり、さらに多断面の二次元画像を同時に得ることも可能である。このＭＲＩ装置はＸ線ＣＴ装置と比べて、軟部組織を高いコントラストで撮影できることや、骨組織の影響を受けないことから骨組織に囲まれた血管などを鮮明に撮影撮影できることなどの点で利点を有する。

【００４４】次に、撮影装置によって得られたこれらの二次元画像や三次元画像を基に、立体モデル化の対象とする腔所の三次元形状に関するデータ（以下、三次元形状データ）を生成する。この三次元形状データの生成に係る一連の処理は、これを可能とするソフトウェアを使用することによって行うが、単一のソフトウェアによって全ての処理が行えない場合には、その過程において複数のソフトウェアを使用しても構わない。尚、現在では、これら一連の処理を自動的に行うソフトウェアは複数市販されており、それらのソフトウェアを利用してもよい。

【００４５】撮影装置によって得られた二次元画像（複数枚必要）或いは三次元画像を基に、撮影領域内の特定部位の三次元形状データを生成する方法には、既に公知の技術として様々な方法が存在しており、全ての方法について詳述することは困難であるため、ここではそれらの方法の一形態を挙げて詳述するが、本発明は以下に記す実施形態に限定されるものではない。

【００４６】ここでは、体軸方向に平行移動しながら等間隔に撮影することによって得られた複数の二次元画像を入力画像として使用する場合について説明するが、他の撮影方法によって得られた二次元画像、或いは三次元画像を入力画像とする場合でも同様な処理を行うことによって腔所の三次元形状データを得ることができる。入

力された各二次元画像は、まず撮影時の撮影間隔に基づいて正確に積層される。次に、各二次元画像上に、画像濃度値に関しての閾値を指定することにより、立体モデル化の対象とする腔所領域のみを各二次元画像中より抽出し、一方で他の領域を積層された二次元画像中より削除する。これにより前記腔所領域に相当する部分の三次元形状が二次元画像を積層した形で与えられ、この各二次元画像の輪郭線を三次元的に補間し、三次元曲面として再構成することにより対象とする腔所の三次元形状データが生成される。尚、この場合は濃度値に関しての閾値を指定することによって、まず入力画像中より腔所領域の抽出を行ったが、この方法とは別に、腔所表面を与える特定濃度値を指定することによって入力画像中より腔所表面の抽出し、三次元補間することによって直接的に三次元曲面を生成することも可能である。また、閾値指定による領域抽出（或いは特定濃度値指定による表面抽出）を行った後に入力画像の積層を行ってもよい。また、三次元曲面の生成はポリゴン近似によって行ってもよい。

【００４７】尚、前記三次元形状データには、該三次元データの生成中、或いは生成後において、形状の修正や変更を施すことが可能である。例えば、撮影により得られた画像データ中には存在しない構造を付加することや、サポートと呼ばれる支持構造を付加することや、或いは前記画像データ中の構造を一部除去することや、腔所の形状を変更することなどが可能であり、これによって、立体モデル１１の内部に形成される腔所の形状を自由に修正或いは変更することができる。さらには、腔所の内部に非積層造形領域を設けることも可能であり、後に説明する内部を中空の構造とし、非積層造形領域３１を設けた積層造形モデルを作製する場合には、そのような非積層造形領域３１を腔所の内部に設けた三次元データを生成しておく。尚、これらの処理は、積層造形システム、或いは積層造形システムに対応したソフトウェアにおいて行ってもよい。

【００４８】次に、生成した腔所の三次元形状データを、必要に応じて積層造形モデル２１の積層造形に使用する積層造形システムに対応した形式に変換し、使用する積層造形システム、或いは使用する積層造形システムに対応したソフトウェアへと送る。

【００４９】積層造形システム（或いは積層造形システムに対応したソフトウェア）では、積層造形時の積層造形モデル２１の配置や積層方向などの各種設定項目の設定を行うと同時に、積層造形中における形状保持などの目的で、サポート（支持構造）をサポートが必要な箇所に付加する（必要なければ付加する必要はない）。最後に、このようにして得られた造形用データを積層造形時の造形厚さに基づいてスライスすることによって、積層造形に直接利用されるスライスデータを生成する。尚、上記の手順とは逆に、スライスデータの生成を行った後にサポートの付加を行ってもよい。また、スライスデータが使用する積層造形システム（或いは積層造形システムに対応したソフトウェア）によって自動的に生成される場合には、スライスデータを生成する必要はない。但し、その場合には積層造形厚さの設定が必要となる。サポートの付加についても同様であり、積層造形システム（或いは積層造形システムに対応したソフトウェア）によってサポートが自動的に生成される場合には、手動で生成する必要はない（手動で生成してもよい）。

【００５０】＜Ｂ．準備工程＞　準備工程は、立体モデル化の対象とする腔所を再現した積層造形モデル２１を積層造形するためのデータを、上記データ生成工程の最終形態として得られるデータと同様な形態にある直接積層造形に利用可能なデータ（以下、積層造形データと呼ぶ）として用意し、積層造形に備える行程であって、図４から図８に示すフローチャートのステップＳＴ１に対応する。但し、この準備工程は積層造形データを用意し積層造形に備える行程であって、積層造形データを生成する行程ではない（積層造形データの生成に関する一切のプロセスは、この準備工程には含まれない）。

【００５１】＜Ｃ．積層造形行程＞　積層造形行程は、立体モデル化の対象とする腔所の形状を再現した前記積層造形モデル２１を、前記準備工程において用意された前記積層造形データを利用した積層造形により作製する行程であって、図４から図８に示すフローチャートのステップＳＴ２に対応する。以下ではこの積層造形行程の実施形態について詳述する。

【００５２】積層造形により作製された腔所を再現した積層造形モデル２１は、後の工程においてロストワックス用消失モデルとして使用される。ロストワックス用消失モデルとは、本来、ロストワックス鋳造法と呼ばれる精密鋳造法で使用される模型のことで、この模型の周囲を微粒子の耐火物やセラミック耐火物でコーティングし、焼成した後にこの模型を溶かして除去することによって、前記消失モデルと同一形状を有する鋳造物を鋳造するための鋳型を製造する目的で使用されるものである。しかしながら、本発明では、積層造形により作製された前記積層造形モデル２１を前記の鋳型製造の目的で使用するのではなく、成形材料によってその周囲全体、或いは周囲の特定部分を満たし、該成形材料を硬化させることによって立体モデル１１を形成した後、立体モデル１１内部に存在する積層造形モデル２１のみを、(a) 加熱により溶融する加熱溶融法、或いは、(b) 溶剤により溶解する溶剤溶解法、或いは、(c) 加熱による溶融と溶剤による溶解とを併用するハイブリッド法、のいずれかを適用することにより選択的に流動化し、立体モデル１１の外部へ溶出することによって、対象とする腔所と同一の形状ないし構造を持つ空洞を内部に有する立体モデル１１を製造する目的で使用する。尚、加熱溶融法は請求項１に、溶剤溶解法は請求項２に、ハイブリッド法

は請求項３にそれぞれ対応する。

【００５３】したがって、本発明においては、積層造形モデル２１の積層造形に使用する材料（以下、造形材料と呼ぶ）と、立体モデル１１の成形に使用する材料（以下、成形材料と呼ぶ）との間には、前記の加熱溶融法と、溶剤溶解法と、ハイブリッド法のいずれを使用するかに依存して、互いに関連のある以下のような制約条件が課される。

【００５４】(1) 前記加熱溶融法により積層造形モデル２１の溶出を行う場合には、下記(1-1)と(1-2)の両方の制約条件を満たす必要がある。

(1-1) 前記造形材料は、加熱により溶融する。

(1-2) 前記成形材料は、制約条件(1-1)に記載の造形材料の溶融温度より低い温度において硬化可能であり、かつ、硬化後においては制約条件(1-1)に記載の造形材料の溶融温度より高い耐熱温度を有する。

【００５５】(2) 前記溶剤溶解法により積層造形モデル２１の溶出を行う場合には、下記(2-1)と(2-2)の両方の制約条件を満たす必要がある。

(2-1) 前記造形材料は、溶剤に溶解する（そのような溶剤が存在する）。

(2-2) 前記成形材料は、制約条件(2-1)に記載の溶剤の内、少なくとも一種類の溶剤（以下、特定溶剤と呼ぶ）に対して耐溶剤性を有する。

【００５６】(3) 前記ハイブリッド法により積層造形モデル２１の溶出を行う場合には、下記(3-1)と(3-2)の両方の制約条件を満たす必要がある。

(3-1) 前記造形材料は、加熱により溶融し、かつ、溶剤に溶解する（そのような溶剤が存在する）。

(3-2) 前記成形材料は、制約条件(3-1)に記載の造形材料の溶融温度より低い温度において硬化可能であり、かつ、硬化後においては制約条件(3-1)に記載の造形材料の溶融温度より高い耐熱温度を有すると同時に制約条件(3-1)に記載の溶剤の内、少なくとも一種類の溶剤（特定溶剤）に対して耐溶剤性を有する。

【００５７】尚、前記積層造形モデル２１は、次の形成行程において該積層造形モデルの周囲を前記成形材料で満たす際に外部から付加される圧力等の外力に耐え得る強度を有する範囲であれば、その内部を中空構造とし、内部に非積層造形領域３１を設けることによって外形面を薄肉化して作製してもよい。これによって、積層造形に所要される時間や造形に伴うコストが低減されるだけでなく、後の溶出行程において積層造形モデル２１の容易な溶出が可能となる。但し、内部を中空の構造とし、非積層造形領域３１を内部に備えた積層造形モデルを造形するためには、先の準備行程において用意する積層造形データが、該造形を行うように生成されている必要がある。

【００５８】上記の加熱溶融法、或いは、溶剤溶解法、或いは、ハイブリッド法に係る制約条件を満足する造形材料の使用を可能とする積層造形には、例えば、粉末焼結方式の積層造形、溶融樹脂噴出方式の積層造形、溶融樹脂押出方式の積層造形などが挙げられる。以下ではこれらの各種積層造形方式について詳述する。但し、本発明の製造方法に係る積層造形はこれらの方式に限定されるものではない。

【００５９】粉末焼結方式の積層造形では、平面状に敷設された粉末材料上に、前記積層造形データに基づいて、レーザ等の加熱用ビームを走査することによって、粉末の表面を溶融させて粉末同士を接合させ、焼結された粉末薄層を形成する。このときすでに焼結されている下層の薄膜との接合も同時に行われる。次に、新たな粉末の薄層が再度上面に供給され、この行程を繰り返して粉末焼結層を順次形成すると同時に積層させていく方式の積層造形を行うことによって積層造形モデル２１の積層造形を行う。

【００６０】溶融樹脂噴出型の積層造形では、前記積層造形データに基づいてノズルヘッドを平面上で走査させながら、ノズルより溶融した造形材料を噴出或いは滴下させ堆積固化させて薄層を形成し、この薄層を順次形成すると同時に積層させていく方式の積層造形を行うことによって積層造形モデル２１の積層造形を行う。

【００６１】溶融樹脂押出型の積層造形では、細いノズルから造形材料を押し出し、この細線状の材料を描画するようにノズルから送り出し固化させながら、前記積層造形データに基づいてノズルヘッドを面上で走査させることによって薄層を形成し、これを積層する方式の積層造形を行うことによって積層造形モデル２１の積層造形を行う。

【００６２】尚、積層造形によって作製された積層造形モデル２１には、積層造形の後に、表面研磨や、表面コーティングの付加など各種の加工（除去加工及び付加加工）を加えることが可能であり、これによって積層造形モデル２１の形状を修正或いは変更することが可能である。これらの加工の一環として、積層造形モデル２１の作製にあたって、積層造形後の除去が必要なサポートを付加した場合には、サポートの除去を行っておく。

【００６３】＜Ｄ．形成行程＞　形成行程は、積層造形行程で得られた前記積層造形モデル２１の周囲を成形材料で満たした後、該成形材料を硬化させ立体モデル１１を形成する行程であって、図４から図８に示すフローチャートのステップＳＴ３に対応する。以下ではこの形成行程の実施形態について詳述する。

【００６４】立体モデル１１の形成は、前記積層造形行程で作製した積層造形モデル２１の周囲を、(1) 後の溶出行程において加熱溶融法を用いる場合は前記制約条件(1-2)を満足する成形材料、(2) 後の溶出行程において溶剤溶解法を用いる場合は前記制約条件(2-2)を満足する成形材料、(3) ハイブリッド法を用いる場合には前記制約条件(3-2)を満足する成形材料で満たすか或いは覆

った後、該成形材料を硬化させることによって行う。尚、積層造形モデル２１の周囲を成形材料で満たす際には、予め用意しておいた所望形状の外型を使用すると良い（この外型の内部を前記積層造形モデル２１と成形材料で満たす）が、外型を使用せず、積層造形モデル２１の表面にゾル或いは粉末状の成形材料を付着させ、これを硬化させることによって立体モデル１１を形成（ディッピング成形、スラッシュ成形）しても良い。外型を使用する場合には、後の外型の除去に備え、使用する前記成形材料との親和力の低い材料を使用することが望ましい。但し、外型の除去を行わず最終的に得られる立体モデル１１の一部としても良い。

【００６５】尚、立体モデル１１の外部形状を外型によって成形する場合、外型の成形面の形状を対象とする腔所を内含する諸器官等の外部形状と一致させることによって、腔所と該腔所を内含する諸器官等の外部形状とを共に再現することが可能である。

【００６６】しかし、立体モデル１１の外部形状は、対象とする腔所を内含する諸器官等の外部形状と一致させる必要はなく、他形状（例えば立方体形状など）で置き換えてもよい。例えば、透明性を有する成形材料を使用して立体モデル１１の製造を行う場合には、該立体モデルの外部形状に平面１４を設けることによって、該立体モデル内部に再現した腔所の認識性を向上させることができる。

【００６７】また、立体モデル１１の外部形状に対しては、成形材料の硬化による形成の後、各種の除去加工や付加加工を行ってもよく、これによって平滑化したり、形状に修正や変更を加えることができる。

【００６８】＜Ｅ．溶出工程＞　次に、積層造形モデル２１を、前記加熱溶融法、或いは、前記溶剤溶解法、或いは、前記ハイブリッド法によって、形成行程で得られた前記立体モデルの外部へ溶出する溶出する溶出行程の実施形態について詳述する。請求項１及び請求項２及び請求項３は、それぞれ前記加熱溶融法及び前記溶剤溶解法及び前記ハイブリッド法を利用して積層造形モデルを溶出することを特徴とする溶出行程を備えており、図４から図８に示すフローチャートではこれらを区別し、請求項１に対応する前記加熱溶融法を利用した溶出行程をステップＳＴ４ａ、請求項２に対応する前記溶剤溶解法を利用した溶出行程をステップＳＴ４ｂ、また請求項３に対応する前記ハイブリッド法を利用した溶出行程をステップＳＴ４ｃと表記した。

【００６９】成形材料を硬化させることにより立体モデル１１の形成を行った後、前記外型を除去すると共に、前記加熱溶融法、或いは前記溶剤溶解法、或いは前記ハイブリッド法によって積層造形モデル２１を立体モデル１１の外部へ溶出し除去する。以下では説明上、外型の除去、積層造形モデル２１の溶出、の順序で記述するが、本発明はこの順序に限定されるものではなく、不要部分の除去は任意の順序で実施すればよい。すなわち、積層造形モデル２１の除去の後に外型を除去することや、積層造形モデル２１の除去途中で外型を除去（或いは外型の除去途中に積層造形モデル２１を除去）することや、積層造形モデル２１と外型とを段階的に交互に除去していくことなどが可能である。

【００７０】外型の除去は、所定の除去方法によって行う。但し、外型を立体モデル１１の一部とする場合には除去は不要である。

【００７１】立体モデル１１内部からの積層造形モデル２１の除去は、前記の加熱溶融法、或いは溶剤溶解法、或いはハイブリッド法によって行う。以下では、それぞれの方法について説明を行う。尚、積層造形モデル２１の溶出は、立体モデル１１より積層造形モデル２１が露出した溶出部分１５より行うが、そのような溶出部分１５が存在しない場合に場合には、立体モデル１１の表面に対して一部除去加工を施し積層造形モデル２１の溶出部分１５を設けておく。尚、この除去加工は、積層造形モデル２１の溶融前或いは溶解前に行っても良いし、積層造形モデル２１を溶融或いは溶解した後に行っても良い。

【００７２】加熱溶融法は、立体モデル１１内部に存在する積層造形モデル２１を、加熱によって選択的に溶融し流動化することにより、立体モデル１１内部より溶出させ、除去を行う方法であり、前記制約条件(1-1)と(1-2)の両方が満足される場合に限ってその適用が可能である。

【００７３】この加熱溶融法では、まず積層造形モデル２１の造形材料の溶融温度より高く、硬化後における立体モデル１１の成形材料の耐熱温度より低い温度に加熱することによって、立体モデル１１内部の積層造形モデル２１を選択的に溶融し流動化させる。溶出前において積層造形モデル２１は、立体モデル１１や、外型除去の順序に応じては外型と一体となった状態にあるが、前記制約条件(1-1)と(1-2)の両方が満足される場合には、これらの構造全体或いは一部分を加熱器等により加熱することによって積層造形モデル２１を選択的に溶融することが可能である。尚、立体モデル１１の加熱は立体モデル外部より行うことも可能であるが、立体モデル内部や積層造形モデル内部に加熱電極を配置することや、外部からレーザー等を照射することなどによって、立体モデル内部より加熱を行うことも可能である。次に、この状態において積層造形モデル２１を立体モデル１１の外部へ溶出させ除去を行う。この積層造形モデル２１の溶出時には、重力や遠心力等の遠隔力や、衝撃や振動を与えることによって発生する慣性等を利用することができるが、積層造形モデル２１が露出した部分に外圧（正圧、負圧）を掛けたり、他の液体を腔所内部に流し込むことによって溶出を促進することも可能である。また、立体モデル１１内部の積層造形モデル２１（特に溶出後に立

体モデル１１内部に残留した積層造形モデル２１の一部）は、固相の状態において、直接外力を加えたり衝撃や振動を与えたり直接把持することなどによって、立体モデル１１の外部に排除してもよい。この際、立体モデル１１内部の積層造形モデル２１を複数の部分に分解してもよい。

【００７４】この加熱溶解法の適用を可能とする積層造形モデル２１の造形材料には、各種の熱可塑性樹脂（サーモプラスチック）（溶融時の流動性が高い（溶融時の粘性が低い）ものが好ましい）やワックス（油脂やパラフィン等）、或いは低融点金属や氷（水）などの他、立体モデル１１の形成に使用する成形材料の耐熱温度より低い温度において溶融する限りにおいて多様な材料を使用することができる。尚、これらの造形材料の選択は立体モデル１１に使用する成形材料の特性に応じて決定する必要がある（造形材料の特性に応じて成形材料を選択してもよい）。

【００７５】溶剤溶解法は、立体モデル１１内部に存在する積層造形モデル２１を、溶剤によって選択的に溶解し流動化することにより、立体モデル１１内部より溶出させ、除去を行う方法であり、前記制約条件(2-1)と(2-2)の両方が満足される場合に限ってその適用が可能である。

【００７６】この溶剤溶解法では、まず前記制約条件(2-2)によって与えられる特定溶剤を使用することにより、立体モデル１１内部の積層造形モデル２１を選択的に溶解し流動化させる。溶出前において積層造形モデル２１は、立体モデル１１や、外型除去の順序に応じては外型と一体となった状態にあるが、前記制約条件(2-1)と(2-2)の両方が満足される場合には、これらの構造全体或いは積層造形モデル２１が露出した部分を含む一部分を前記特定溶剤に接触させることによって積層造形モデル２１を選択的に溶解することが可能である。次に、この状態において積層造形モデル２１を立体モデル１１の外部へ溶出させ除去を行う。この積層造形モデル２１の溶出時には、加熱溶融法の場合と同じく、重力や遠心力等の遠隔力や、衝撃や振動を与えることによって発生する慣性等を利用することができる他、積層造形モデル２１が露出した部分に外圧（正圧、負圧）を掛けたり、他の液体を腔所内部に流し込むことなどによって溶出を促進することも可能である。また、立体モデル１１内部の積層造形モデル２１（特に溶出後に立体モデル１１内部に残留した積層造形モデル２１の一部）は、固相の状態において、直接外力を加えたり衝撃や振動を与えたり直接把持することなどによって、立体モデル１１の外部に排除してもよい。この際、立体モデル１１内部の積層造形モデル２１を複数の部分に分解してもよい。

【００７７】この溶剤溶解法の適用を可能とする積層造形モデル２１の造形材料には、シアノアクリレート（アセトンに溶解）や澱粉（水等に溶解）等の接着物質や、トルエンスルホンアミド樹脂（アセトン等に溶解）、ポリビニルアルコール（水等に溶解）などの可溶剤溶解性を有する各種樹脂、ワックス（油脂やパラフィン等）などの使用が可能である。尚、溶剤溶解法を実施する場合には、立体モデル１１に使用する成形材料が積層造形モデル２１の溶解に使用する溶剤に対して耐溶剤性を有する必要があり、積層造形モデル２１に使用する造形材料の選択は立体モデル１１に使用する成形材料の特性に応じて決定するとよい（造形材料の特性に応じて成形材料を選択してもよい）。

【００７８】ハイブリッド法は、先に詳述した加熱溶融法と溶剤溶解法とを併用することによって、立体モデル１１内部に存在する積層造形モデル２１を、立体モデル１１内部より溶出させ、除去を行う方法であり、前記制約条件(3-1)と(3-2)の両方が満足される場合に限ってその適用が可能である。

【００７９】このハイブリッド法では、(1) 加熱によって立体モデル１１内部より積層造形モデル２１を溶出する行程と、(2) 溶剤よって立体モデル１１内部より積層造形モデル２１を溶出する行程と、を任意の順序で実施することによって（或いは、各工程を任意の順序で複数回実施することによって）、立体モデル１１内部より前記積層造形モデル２１の除去を行う。以下では、これらの各工程について詳述する。

【００８０】(1) 加熱によって立体モデル１１内部より積層造形モデル２１を溶出する行程では、まず積層造形モデル２１の造形材料の溶融温度より高く、硬化後における立体モデル１１の成形材料の耐熱温度より低い温度に加熱することによって、立体モデル１１内部の積層造形モデル２１を選択的に溶融し流動化させる。溶出前において積層造形モデル２１は、立体モデル１１や、外型除去の順序に応じては外型と一体となった状態にあるが、前記制約条件(3-1)と(3-2)の両方が満足される場合には、これらの構造全体或いは一部分を加熱器等により加熱することによって積層造形モデル２１を選択的に溶融することが可能である。尚、立体モデル１１の加熱は立体モデル外部より行うことも可能であるが、立体モデル内部や積層造形モデル内部に加熱電極を配置することや、外部からレーザー等を照射することなどによって、立体モデル内部より加熱を行うことも可能である。次に、この状態において積層造形モデル２１を立体モデル１１の外部へ溶出させ除去を行う。この積層造形モデル２１の溶出時には、重力や遠心力等の遠隔力や、衝撃や振動を与えることによって発生する慣性等を利用することができるが、積層造形モデル２１が露出した部分に外圧（正圧、負圧）を掛けたり、他の液体を腔所内部に流し込むことなどによって溶出を促進することも可能である。また、立体モデル１１内部の積層造形モデル２１（特に溶出後に立体モデル１１内部に残留した積層造形モデル２１の一部）は、固相の状態において、直接外力

を加えたり衝撃や振動を与えたり直接把持することなどによって、立体モデル１１の外部に排除してもよい。この際、立体モデル１１内部の積層造形モデル２１を複数の部分に分解してもよい。

【００８１】(2) 溶剤によって立体モデル１１内部より積層造形モデル２１を溶出する行程では、まず前記制約条件(3-2)によって与えられる特定溶剤を使用することにより、立体モデル１１内部の積層造形モデル２１を選択的に溶解し流動化させる。溶出前において積層造形モデル２１は、立体モデル１１や、外型除去の順序に応じては外型と一体となった状態にあるが、前記制約条件(3-1)と(3-2)の両方が満足される場合には、これらの構造全体或いは積層造形モデル２１が露出した部分を含む一部分を前記特定溶剤に接触させることによって積層造形モデル２１を選択的に溶解することが可能である。次に、この状態において積層造形モデル２１を立体モデル１１の外部へ溶出させ除去を行う。この積層造形モデル２１の溶出時には、先と同じく、重力や遠心力等の遠隔力や、衝撃や振動を与えることによって発生する慣性等を利用することができる他、積層造形モデル２１が露出した部分に外圧（正圧、負圧）を掛けたり、他の液体を腔所内部に流し込むことなどによって溶出を促進することも可能である。また、立体モデル１１内部の積層造形モデル２１（特に溶出後に立体モデル１１内部に残留した積層造形モデル２１の一部）は、固相の状態において、直接外力を加えたり衝撃や振動を与えたり直接把持することなどによって、立体モデル１１の外部に排除してもよい。この際、立体モデル１１内部の積層造形モデル２１を複数の部分に分解してもよい。

【００８２】ハイブリッド法では、上記の各工程を各工程を任意の順序で、必要に応じて複数回実施することが可能であり、例えば、加熱より積層造形モデル２１を溶融し流動化させることにより積層造形モデル２１の大半を立体モデル１１内部より溶出した後、立体モデル１１を室温まで冷却し、先の溶出によって形成された立体モデル１１内部の空洞領域に前記制約条件(3-2)によって与えられる特定溶剤を注入することで、表面張力などにより立体モデル１１内部に残留した積層造形モデル２１の一部を再度流動化し、注入した溶剤と共に立体モデル１１の外部へ溶出することなども可能である。

【００８３】このハイブリッド法の適用を可能とする積層造形モデル２１の造形材料としては、前記加熱溶解法と前記溶剤溶解法の双方の適用を可能とする材料を使用することができ、トルエンスルホンアミド樹脂などの熱可塑性樹脂（サーモプラスチック）や、ワックス（油脂やパラフィン等）などの使用が可能である。

【００８４】加熱により積層造形モデル２１の溶融を行う加熱溶融法やハイブリッド法によれば、積層造形モデル２１の露出面積によらず立体モデル１１内部への熱拡散の進行に伴って非接触にて積層造形モデル全体を溶融し流動化することが可能であり、溶剤溶解法のように物理的な接触によって接触領域から次第に積層造形モデル２１を溶解する場合には溶出が困難であるような複雑な形状、例えばアスペクト比の高い細管状の腔所などを容易に再現することが可能である。

【００８５】以上では、加熱溶融法及び溶剤溶解法及びハイブリッド法により積層造形モデル２１を立体モデル１１の内部より溶出する方法について説明を行ったが、これらの方法以外にも、露出部分から積層造形モデル２１に直接外力を与えることや、立体モデル１１の外部より衝撃力や振動等を与えることや、直接把持することなどによってなどによって、立体モデル１１内部より積層造形モデル２１を排除することも可能である。またこの際、立体モデル１１内部の積層造形モデル２１を複数の部分に分解し、分解された各部分を立体モデル１１内部より取り出してもよい。尚、この方法によって積層造形モデル２１の除去を行う場合には、内部を中空として積層造形モデル２１を作製することによって、積層造形モデル２１の分解を容易化することが可能である。但しこの方法は、積層造形モデル２１の形状が複雑である場合や、積層造形モデル２１がアスペクト比の高い形状を有する場合には適用は困難である。

【００８６】内部に腔所を再現した立体モデル１１は、立体モデル化の対象とする腔所を複数に分割し、分割された各腔所に対して本発明の製造方法を実施することにより各腔所を内部に再現した立体モデルを作製し、得られたそれぞれの腔所に対する立体モデルを組み合わせることによって、立体モデル化の対象とする腔所全体を再現した立体モデル１１を得ることも可能である。この場合、各腔所に対する立体モデルはそれぞれ異なる製造方法によって製造することも可能である。但し、本発明は複数に分割されたそれぞれの腔所に対する立体モデル及びその製造方法も発明の対象とするものである。

【００８７】＜Ｆ．拡散除去行程＞　請求項５に記載の内部に腔所を再現した立体モデルの製造方法は、溶出行程の後の行程、或いは、溶出行程の途中に介在する行程として、溶出行程において前記立体モデルの内部へと拡散した前記造形材料の成分を、立体モデルを再度加熱することによって蒸発させ、立体モデル内部より除去する拡散除去行程を備えることを特徴とする。以下では、この拡散除去行程の実施形態について詳述する。この拡散除去行程は、溶出行程の後の行程として実施するか、溶出行程の途中に介在する行程として実施するかによって、それぞれ図８（ａ）と図８（ｂ）に区別してフローチャートを示した。図８（ａ）のフローチャートでは拡散除去行程はＳＴ５に対応する。一方、図８（ｂ）のフローチャートでは拡散除去行程と溶出行程を一つのステップとして示し、溶出行程を前記加熱溶融法、前記溶剤用解法、前記ハイブリッド法のいずれを利用して実施するかによって、それぞれステップＳＴ６ａ、ステップＳ

Ｔ６ｂ、ステップＳＴ６ｃとして区別した。

【００８８】形成行程において成形材料の硬化により形成された立体モデル１１が、特に、シリコーンゴム等の弾性を有する材料によって構成される場合、溶出行程において積層造形モデル２１を加熱によって溶融した際に、積層造形モデル２１を構成する造形材料の成分（以下、拡散成分と呼ぶ）の一部が立体モデル１１の内部へと拡散し、立体モデル１１内部に染色等を発生する場合がある。

【００８９】この拡散は、加熱により積層造形モデル２１を溶融した際に、積層造形材料２１を構成する造形材料の成分（以下、拡散成分と呼ぶ）の一部が気化（蒸発）し、立体モデル１１内部へと拡散することに起因して発生する。積層造形モデル２１の溶出後に立体モデル１１内部に残留したこの拡散成分は、多くの場合（拡散成分が立体モデル１１の構成材料と化学的に結合する場合などを除く）、立体モデル１１を再度加熱することによって再度気化する（蒸発させる）ことが可能である。立体モデル１１の内部で気化した拡散成分の一部は、拡散により立体モデル１１内部より立体モデル１１の外部へと排出されるため、これによって立体モデル１１内部より拡散成分を除去することが可能である。さらに立体モデル１１の内部で気化した拡散成分は、冷却することによって、その一部、場合によってはその全てが立体モデル表面へと析出され、これによって立体モデル１１内部より拡散成分を除去することも可能であり、拡散除去行程では、これらの方法を利用することによって立体モデル１１内部より拡散成分の除去を行う。尚、成形材料としてエラストマー等の架橋ポリマーを使用する場合には、架橋密度の高い材料を選択して使用することによって、これらの方法による拡散除去の効果を高めることが可能である。

【００９０】また立体モデル１１内部の拡散成分、特に色素などは加熱により分解が可能な場合も多く、これによって拡散により生じた染色を除去或いは変色することも可能である。但し、立体モデル１１の加熱は、立体モデル１１を構成する材料の耐熱温度より低い範囲内で行う必要があり、この方法は、この温度範囲内で拡散成分の分解が可能な場合にのみ適用が可能である。

【００９１】以上、本発明の立体モデルの製造方法によれば、対象とする腔所の積層造形モデル２１を積層造形するためのデータを基に、短時間で、対象とする腔所を内部に再現した立体モデルを製造することが可能である。また複雑形状の腔所も容易に再現することが可能である。また請求項４に記載の製造方法によって立体モデルを製造することによって、患者毎に患部等を再現した立体モデルを短時間にて、かつ、対象とする身体に低侵襲或いは無侵襲にて製造することが可能であり、製造した立体モデルを手術前計画や、手術前の手術試行に利用することも可能とされる。

【００９２】＜Ｇ．内部に腔所を再現した立体モデル＞

以下では、本発明の内部に腔所を再現した立体モデルについて、添付図面に示す実施の一形態に基づき、詳細に説明を行う。

【００９３】本発明の内部に腔所を再現した立体モデルは、(a) 成形材料の硬化により形成された立体モデル形成部分と、(b) 積層造形モデルを溶出することにより形成された空洞部分と、を備えることを特徴とするものである。請求項９に記載の内部に腔所を再現した立体モデルは、前記空洞部分が加熱により積層造形モデルを溶解し溶出することによって形成されることを特徴する。請求項１０に記載の内部に腔所を再現した立体モデルは、前記空洞部分が溶剤により積層造形モデルを溶解し溶出することによって形成されることを特徴する。また請求項１１に記載の内部に腔所を再現した立体モデルは、前記空洞部分が加熱による溶融と、溶剤による溶解とを併用して積層造形モデルを溶出することによって形成されることを特徴とする。

【００９４】以下、図面を用いて説明する

【００９５】立体モデル１１は、成形材料の硬化により形成された立体モデル形成部分１２と、積層造形モデル２１を溶出することにより形成された空洞部分１３とを備える。

【００９６】この内、立体モデル形成部分１２は、積層造形モデル２１の周囲を成形材料で満たすか、或い積層造形モデル２１の周囲にゾル或いは粉末状の成形材料を付着させた後、成形材料を硬化させることによって形成される部分であって、その外部形状は、外型を使用して成形を行う場合には外型の成形面の形状に一致し、外型を使用せず成形材料を付着させ硬化することによって成形する場合には、成形材料付着時の成形材料の状態、並びに成形材料の硬化時における形状（体積）変化特性等によって決定される。

【００９７】立体モデル１１の外部形状は、立方体形状に限定されることなく、円柱形状や球形状など任意の形状として形成してもよく、或いは対象とする腔所を内含する諸器官等の外部形状と同一の形状として形成してもよい。また積層造形モデル２１の周囲に成形材料を付着させ硬化させることによって、薄膜状、或いは一定の厚みを持った薄肉状の形状として形成してもよい。

【００９８】立体モデル形成部分１２に使用できる成形材料としては、生体組織が有する弾性を再現するためエラストマー等の高い弾力性を有する材料を使用することが好ましい。しかし、高い弾力性を有する材料を使用することは必須ではなく、樹脂等の一般的な成形材料を使用してもよい。立体モデル形成部分１２に使用できる成形材料としては、例えば、シリコーンゴム（シリコーンエラストマー、シリコーンゲル）や熱硬化性のポリウレタンエラストマー等のエラストマー或いはゲルの他、シリコーン樹脂、エポキシ樹脂、ポリウレタン、不飽和ポ

リエステル、フェノール樹脂、ユリア樹脂等の熱硬化性樹脂や、ポリメタクリル酸メチル等の熱可塑性樹脂を単独で、或いは複数組み合わせて使用することができる。尚、これらのエラストマーや樹脂等の成形材料は、(1)触媒や硬化剤等を加えることにより室温で化学反応し硬化する（触媒硬化或いはポリオール硬化）ものや、(2)湿気により室温で化学反応し硬化する（湿気硬化）ものや、(3)酸化により室温で化学反応し硬化する（酸化硬化）ものや、(4)加熱することにより、或いは触媒や硬化剤等を加えた後に加熱することにより化学反応し硬化する（加熱硬化）ものや、(3)(1)から(4)の内、複数の方法によって硬化するものを使用することができる。

【００９９】空洞部分１３は、積層造形モデル２１の周囲を成形材料で満たすか或い積層造形モデル２１の周囲にゾル或いは粉末状の成形材料を付着させた後、成形材料を硬化させることによって形成される立体モデル形成部分１２の内部より、先の積層造形モデル２１を溶出することによって形成される部分であって、立体モデル形成部分１２の内部表面に囲まれることによって形作られる部分である。

【０１００】この空洞部分１３は、立体モデル化の対象とする腔所を再現した部分であって、立体モデル化の対象とする腔所の三次元形状と実質的に同一の三次元形状を有することを特徴とするが、立体モデル化の対象とする腔所の三次元形状と、この空洞部分１３の三次元形状は完全に同一である必要はない。すなわち、形状に修正や変更を加えてあってもよいし、形状再現の精度が低いことに起因して両者の形状が異なっていてもよい。尚、立体モデル化の対象とする腔所は、実存する身体（生体或いは死体）に存在する腔所（或いはそれを基に修正や変更を加えたもの）であってもよいし、資料や知識を基にして得られる腔所であってもよい。また立体モデル化の対象とする腔所は、人間の身体に存在する腔所の他、人間以外の動物の身体に存在する腔所であってもよい。

【０１０１】人間の身体に存在する腔所には、例えば、心臓の内腔、胃の内腔、腸の内腔、子宮の内腔、血管の内腔、尿管の内腔などの諸器官の内腔の他、これらの諸器官や体壁などの幾何学的配置によって構成される口腔、鼻腔、口峡、中耳腔、体腔、関節腔、囲心腔などがあり、空洞部分１３の三次元形状は、例えばこれらの腔所の三次元形状を再現した形状とすることができる。

【０１０２】立体モデル形成部分１２に使用する成形材料は、硬化後において透明性を有する材料を使用してもよい。透明性を有する種が存在する成形材料には、例えば、シリコーンゴム（シリコーンエラストマー、シリコーンゲル）、熱硬化性のポリウレタンエラストマー等のエラストマー或いはゲルの他、シリコーン樹脂、エポキシ樹脂、ポリウレタン、不飽和ポリエステル、フェノール樹脂、ユリア樹脂等の熱硬化性樹脂や、ポリメタクリル酸メチル等の熱可塑性樹脂などがある。このような透明性を有する成形材料を使用して立体モデル形成部分１２を形成することによって、内部に存在する、腔所を再現した空洞部分１３の認識性に優れた立体モデル１１を得ることができる。

【０１０３】また立体モデル形成部分１２の外部形状、すなわち立体モデル１１の外部形状には平面１４を設けることが可能である。このような平面１４は、立体モデルの外部形状を外型を使用して成形する場合には、使用する外型の成形面上に平面を設けることによって形成することが可能であり、また、成形材料の硬化により立体モデル形成部分１２を形成した後に各種の除去加工や付加加工を行うことによって形成することも可能である。立体モデル１１の外部形状に平面１４を設けることによって、設けられた平面１４上において、平行光に対する光の屈折方向を一定に揃えることができるため、特に立体モデル形成部分１２を透明性を有する成形材料によって形成した場合、立体モデル１１内部に存在する、腔所を再現した空洞部分１３の認識性に優れた立体モデルを得ることができる。また立体モデル１１の底部に平面１４を設けることによって、立体モデルを平らな場所に置く場合に安定性が向上する。

【０１０４】腔所を再現した空洞部分１３は立体モデル形成部分１２の内部表面によってその周囲を囲まれる。本発明の立体モデル１１は、医療器具等を挿入し手術等の試行に利用することも可能であり、そのような利用を目的とする場合には、立体モデル形成部分１２の内部表面は腔所を内含する諸器官等の内部表面と似通った接触特性を呈することが望ましく、そのため立体モデル形成１２には生体組織が有する弾力性等の接触特性を良好に再現することのできる成形材料を使用することが好ましい。シリコーンゴム（シリコーンエラストマー或いはシリコーンゲル）は、弾力性に優れており生体組織が有する弾力性を再現するのに適している。また弾力性（硬さ）に関しては幅広いグレードが存在するため、立体モデル化の対象とする腔所の特性に応じて最適な弾力性を有するグレードを選択することが可能である。さらにシリコーンゴム（シリコーンエラストマー或いはシリコーンゲル）は、一般に非粘着性を示し、潤滑剤を使用することによって表面の潤滑性にも優れており、生体組織が有する物理的諸特性を再現するのに非常に適している。よって、シリコーンゴム（シリコーンエラストマー或いはシリコーンゲル）を使用して立体モデル形成部分１２を形成することによって、対象とする腔所の形状のみならず、生体組織が有する弾力性等の接触特性までを良好に再現した立体モデルを得ることができる。また、シリコーンゴム（シリコーンエラストマー或いはシリコーンゲル）には、非常に高い透明性を有する種も存在するため、そのような透明性に優れたシリコーンゴム（シリコーンエラストマー或いはシリコーンゲル）を使用して立体モデル形成部分１２を形成することによって、立体モ

デル１１内部に存在する、腔所を再現した空洞部分１３の認識性に優れた立体モデルを得ることも可能である。また、シリコーンゴム（シリコーンエラストマー或いはシリコーンゲル）は、一般に化学的に不活性であり、耐候性（耐薬品性）、耐熱性にも優れるため、本発明の内部に腔所を再現した立体モデルの製造方法の実施にも特に適している。

【０１０５】本発明の内部に腔所を再現した立体モデルは、例えば、医療分野において、患部、或いは患部とその周辺領域の形状を再現することで、医師らは患部や患部周辺の三次元形状や構造を直感的に正確に把握することができるだけでなく、さらに立体モデル内部の腔所を再現した空洞部分に、カテーテルや内視鏡等の各種の医療器機を実際に挿入し手術の試行等に利用することも可能とされる。手術試行の具体例としては、動脈瘤や血管狭窄部或いは血栓部等の諸疾患を有する血管内腔を再現した立体モデルを利用して、カテーテルを挿入することにより動脈瘤塞栓術、血管拡張術やステント留置術、動脈閉塞術等の手術の試行を行うことや、胃癌や食道癌等の諸疾患を有する胃内腔或いは食道内腔、或いは大腸癌や大腸ポリープを有する大腸内腔を再現した立体モデルを利用して、内視鏡を挿入することにより癌やポリープ等の切除術に対する手術の試行を行うことが可能である。このような手術試行は鼻腔や耳腔、腹腔や子宮など様々な部位に対して実施することが可能である。

【０１０６】このように、本発明の内部に腔所を再現した立体モデルは、医療分野において、患部やその周辺部分の形状や状態等を把握する目的での利用が可能な他、高度な技術と熟練を要する手術を円滑に遂行するため、或いは研修の成果を大幅に向上させるための補助手段として大変に有用である。また本発明の内部に腔所を再現した立体モデルの利用は、医療分野に限定されることなく、理科教育分野や医学教育分野等の教育分野等、様々な分野で利用することが可能である。

【０１０７】

【実施例】以下、本発明について、実施例を挙げて具体的に説明するが、本発明はこれらの実施例のみに限定されるものではなく、実際の実施に際しては記載するプロセスの全てを経る必要はない。特に、［実施例１］では、積層造形モデル２１を積層造形するためのデータの生成に関した請求項４に対応するプロセスについても記述しているが、積層造形モデル２１を積層造形するためのデータを生成するプロセスは、請求項１から請求項３に記載の準備工程の範囲外にあり、必ずしも実施する必要はない。

【０１０８】［実施例１］まず、立体モデル化の対象とする脳血管及び及び患部である脳脳動脈の形状に関する三次元データを得るため、撮影領域の血管内部へ造影剤を投与しながら、患者の頭部に対して、０．３５×０．３５×０．５mmの空間分解能を持つヘリカルスキャン方式のＸ線ＣＴ装置により撮影を行った。撮影により得られた三次元データは、３次元ＣＡＤソフトへの受け渡しのため、体軸方向に等間隔に配列された５００枚の５１２×５１２の解像度をもつ２５６階調の二次元画像に再構成した後、各二次元画像に対応する画像データを撮影方向に一致する順序で前記Ｘ線ＣＴ装置に内蔵されたドライブにより５．２５インチ光磁気ディスクへ保存した。

【０１０９】次に、パーソナルコンピュータに外部接続した５．２５インチ光磁気ドライブによって、前記画像データをコンピュータ内部の記憶装置へ取り込み、この画像データから、市販の三次元ＣＡＤソフトを利用して、積層造形に必要とされるＳＴＬ形式（三次元曲面を三角形パッチの集合体として表現する形式）の三次元形状データを生成した。この変換では、入力された二次元画像を撮影間隔に基づいて積層することによって、濃度値をスカラー量とする三次元のスカラー場を構築し、そのスカラー場上に血管内表面を与える特定の濃度値を指定することによって、アイソサーフェス（特定スカラー値の境界面）として血管内腔の三次元形状データを構築した後、構築されたアイソサーフェスに対して三角形ポリゴン近似のレンダリングが行われる。

【０１１０】生成したＳＴＬ形式の三次元形状データを、次に溶融樹脂噴出方式の積層造形システムへと転送し、造形システム内でのモデルの配置や積層方向、積層厚さを決定すると同時にモデルに対してサポートを付加した。このようにして生成された積層造形用のデータをコンピュータ上で所定の積層造形厚さ（１３μm）にスライスして多数のスライスデータを生成した。そして、このようにして得られた各スライスデータに基づいて、ｐ－トルエンスルホンアミドとｐ－エチルベンゼンスルホンアミドを主成分とした造形材料（融点：約１００度、アセトンに容易に溶解）を加熱により溶融して噴出することにより、各スライスデータに一致する形状を有する指定厚さの樹脂硬化層を一面ずつ積層形成することよって積層造形を行った。最終層の形成の後にサポートを除去することによって、脳血管内腔領域の積層造形モデルを作成した。

【０１１１】一方で、立体モデル１１の外部形状を成形する目的で使用する外型を機械加工により作成した。この外型の内部成形面は立方体形状をしており、外型を構成する部材は組立・分離が可能である。この注型成形用外型の内部に積層造形システムにより作成した積層造形モデル２１を配置した後、モデルの端部を外型内面に接着することによって両者の固定することにより型を作成した。

【０１１２】このようにして作成された型の内部に、加熱による短時間での重合硬化が可能な透明度の高い二液混合型の液体状シリコーンエラストマーを流し込み、７５℃の恒温層内で１時間加熱することにより重合硬化さ

せ、立体モデルを形成した。そして十分な硬化が得られたことを確認した後、外型を構成する部材を順次分離して取り外した。

【０１１３】このようにして得られた立方体形状の立体モデル１１を１２０℃の恒温層内で１時間加熱することにより、立体モデル１１の内部に存在する積層造形モデル２１を溶融し、立体モデル１１の外部へ溶出を行った。尚、この溶出は、積層造形モデル２１の端部が立体モデル１１より露出していた部分から行った。加熱溶融による造形材料の溶出後、ブロック全体を室温まで冷却し、積層造形モデルの溶出によって立体モデル１１の内部に形成された空洞部にアセトンを注入した。これにより、立体モデル１１内部に残留した造形材料を溶解し、溶液化した造形材料を立体モデルの外部へ溶出した。これにより、立体モデル１１内部より積層造形モデル２１が完全に除去され、脳血管内腔を内部に再現した立体モデルを得た。

【０１１４】最後に、積層造形モデル２１の溶融時に立体モデル１１の内部へと拡散した前記造形材料の成分を立体モデル１１の内部より排除するため、再度、１２０℃に設定された恒温層内で前記立体モデル１１を１時間加熱し、前記成分を蒸発させ、これによって除去を行った。

【０１１５】このようにして作製した脳血管内腔の立体モデル１１は、成形材料に透明度の高いシリコーンエラストマーを使用したことによって高い透明性を有し、さらに外部形状を立方体形状として平面１４を設けたことによって、立体モデル１１内部に再現された脳血管内腔の形状や構造、及び、患部を再現した脳動脈瘤の形状が目視によって容易かつ正確に認識されるものであった。さらに、作製した脳血管の立体モデルは、その内部に潤滑液を注入することで、医療器具であるカテーテルの挿入に対して、実際の脳血管手術時と非常によく似た挿入感覚や操作感覚を呈するものであった。図１、図２はそれぞれ、本発明の実施により最終的に製造された脳血管内腔の立体モデルの概略図、及び、積層造形システムにより作製された脳血管内腔領域の積層造形モデルを示したものである。

【０１１６】

【発明の効果】以上説明したように、請求項１から請求項３のいずれかの発明の方法によれば、データに基づいて積層造形により作製した積層造形モデルを溶出することによって、該積層造形モデルと同一形状の空洞を形成するため、前記データを腔所の形状に基づいて生成することで任意形状の腔所を精密に再現することができる。また、積層造形により直接立体モデルの造形を行う場合とは異なり、積層造形では使用が不可能である多様な材料によって立体モデルを製造することができる。さらに、これら方法によれば、立体モデルは成形材料の硬化によって形成されるため、積層造形によって直接立体モデルの造形を行う場合とは異なり、一般に、造形体積によらず短時間で立体モデルを得ることができる。その結果、多様な材料により、内部に任意形状の腔所を再現した立体モデルを、造形体積によらず短時間で製造し、得ることができる。

【０１１７】また、請求項４の発明の方法によれば、腔所を再現した積層造形モデルを積層造形するためのデータを、撮影装置による撮影に基づいて生成するため、該データを、対象とする身体に対して低侵襲或いは無侵襲によって得ることができる。その結果、対象とする身体に対して低侵襲或いは無侵襲によって、対象とする腔所を内部に再現した立体モデルを得ることができる。

【０１１８】また、請求項５の発明の方法によれば、溶出行程において立体モデルの内部へ拡散した積層造形モデルの造形材料の成分を蒸発させ、これによって立体モデルの内部より除去することができる。その結果、前記成分が、一部、或いは、完全に除去された立体モデルを得ることができる。

【０１１９】また、請求項６から請求項８のいずれかの発明の方法によれば、加熱による溶融、或いは溶剤による溶解、或いは加熱による溶融と溶剤による溶解の両方が可能とされる造形材料を使用して積層造形を行うことが可能であり、該造形材料を構成材料として含む積層造形モデルを作製することができる。その結果、作製した積層造形モデルを立体モデルの内部より溶出することができ、内部に腔所を再現した立体モデルを得ることができる。

【０１２０】また、請求項９から請求項１１のいずれかの発明は、上記の各方法発明で製造される内部に腔所を再現した立体モデルとして、内部に任意形状の腔所を再現できるという利点を有している。

【０１２１】また、請求項１２又は請求項１３の発明は、上記の各方法発明で製造される内部に腔所を再現した立体モデルとして、内部に再現した腔所の認識性に優れるという利点を有している。

【０１２２】また、請求項１４の発明は、上記の各方法発明で製造される内部に腔所を再現した立体モデルとして、柔軟性を有するという利点を有している。

【図面の簡単な説明】

【図１】本発明の内部に腔所を再現した立体モデルの実施の一形態を示した全体斜視図である。

【図２】積層造形により作製された、腔所を再現した積層造形モデルの実施の一形態を示した全体斜視図である。

【図３】図２に示す腔所を再現した積層造形モデルを中空の構造として作製した場合の断面構造を示す要部断面拡大斜視図である。

【図４】請求項１に記載の内部に腔所を再現した立体モデルの製造方法の概略を説明したフローチャートである。

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【図５】請求項２に記載の内部に腔所を再現した立体モデルの製造方法の概略を説明したフローチャートである。

【図６】請求項３に記載の内部に腔所を再現した立体モデルの製造方法の概略を説明したフローチャートである。

【図７】請求項４に記載の内部に腔所を再現した立体モデルの製造方法の概略を説明したフローチャートである。

【図８】請求項５に記載の内部に腔所を再現した立体モデルの製造方法の概略を説明したフローチャートである。

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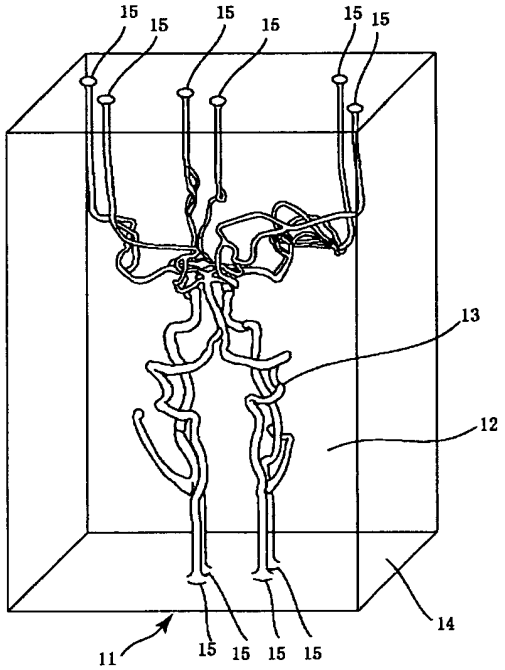
＊【図９】請求項６に記載の内部に腔所を再現した立体モデルの製造方法の概略を説明したフローチャートである。

【符号の説明】

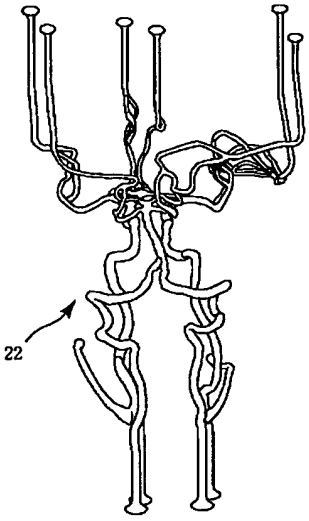
１１　立体モデル
１２　立体モデル形成部分
１３　空洞部分
１４　平面
１５　溶出部分
２１　積層造形モデル
３１　非積層造形領域

＊

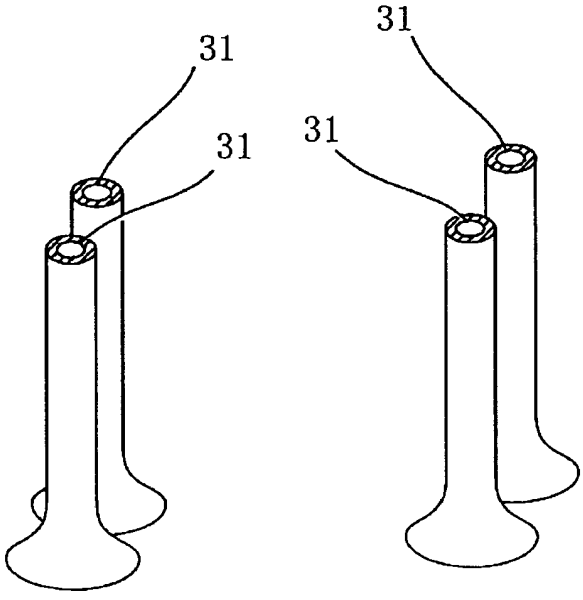
【図１】



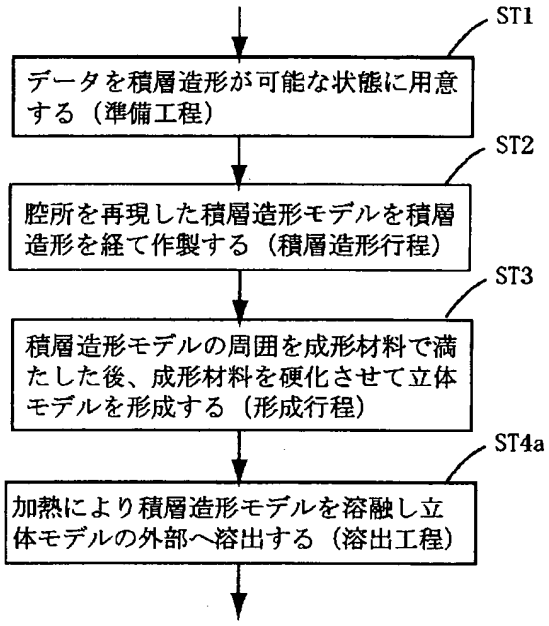
【図２】



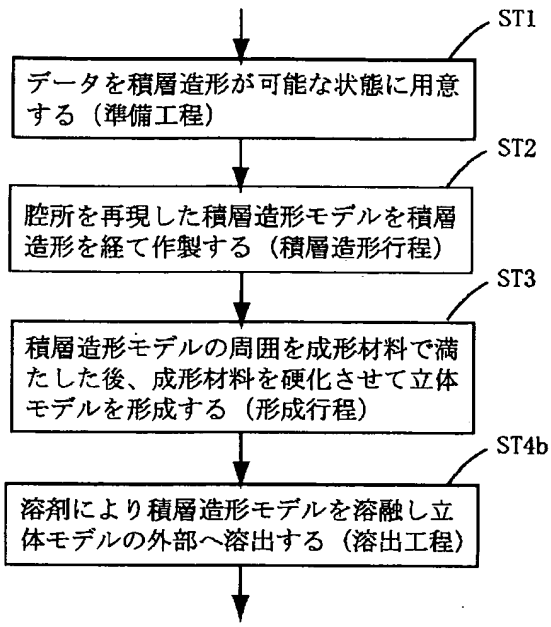
【図３】



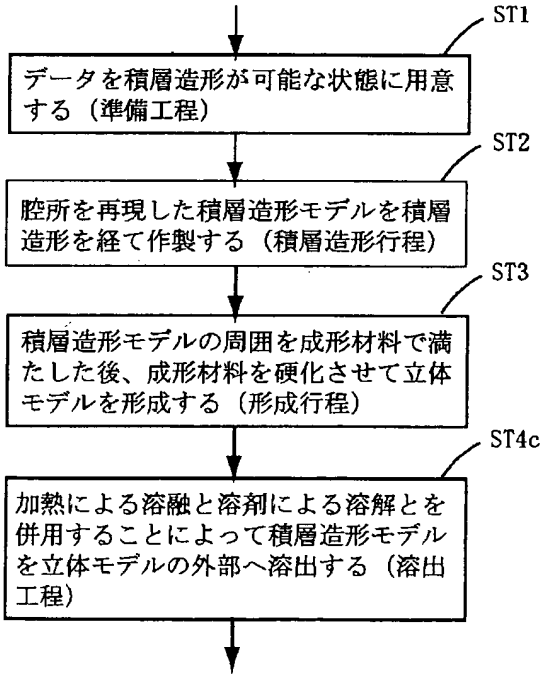
【図４】


ST1
データを積層造形が可能な状態に用意する（準備工程）
ST2
腔所を再現した積層造形モデルを積層造形を経て作製する（積層造形行程）
ST3
積層造形モデルの周囲を成形材料で満たした後、成形材料を硬化させて立体モデルを形成する（形成行程）
ST4a
加熱により積層造形モデルを溶融し立体モデルの外部へ溶出する（溶出工程）

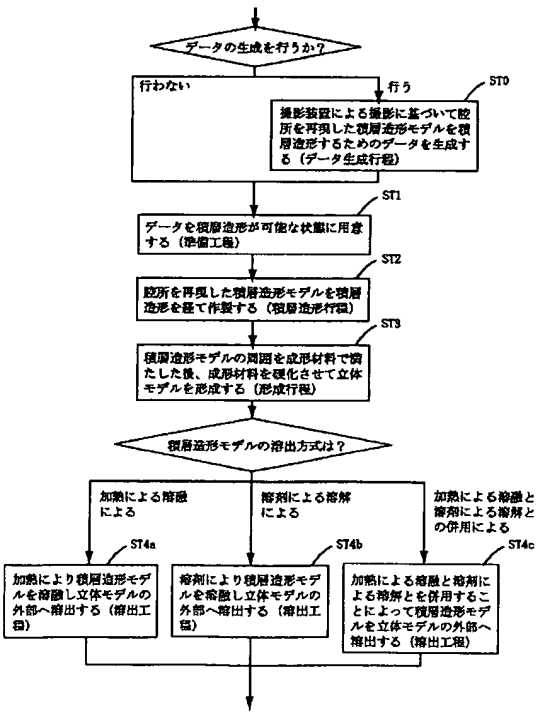
【図５】


ST1
データを積層造形が可能な状態に用意する（準備工程）
ST2
腔所を再現した積層造形モデルを積層造形を経て作製する（積層造形行程）
ST3
積層造形モデルの周囲を成形材料で満たした後、成形材料を硬化させて立体モデルを形成する（形成行程）
ST4b
溶剤により積層造形モデルを溶融し立体モデルの外部へ溶出する（溶出工程）

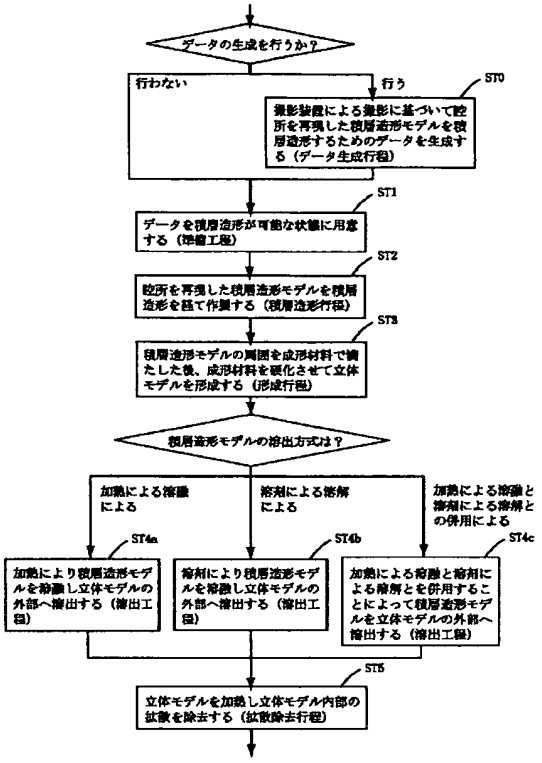
【図６】


ST1
データを積層造形が可能な状態に用意する（準備工程）
ST2
腔所を再現した積層造形モデルを積層造形を経て作製する（積層造形行程）
ST3
積層造形モデルの周囲を成形材料で満たした後、成形材料を硬化させて立体モデルを形成する（形成行程）
ST4c
加熱による溶融と溶剤による溶解とを併用することによって積層造形モデルを立体モデルの外部へ溶出する（溶出工程）

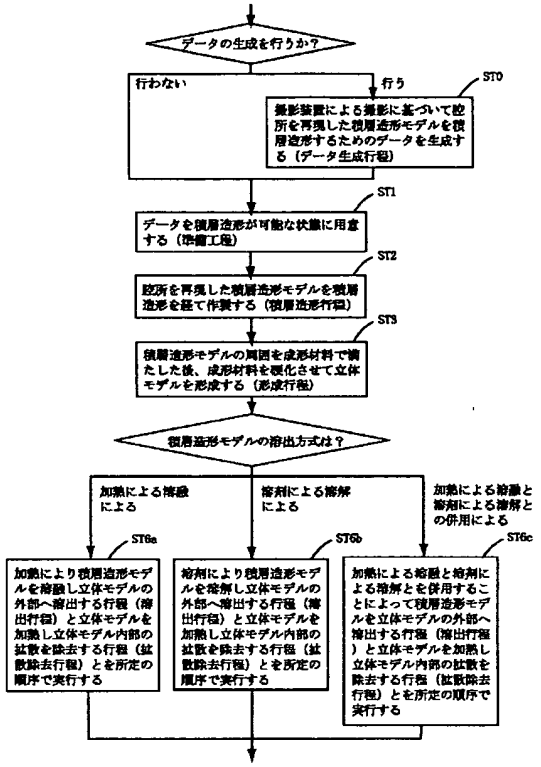
【図７】


データの生成を行うか？
行わない
行う
ST0
撮影装置による撮影に基づいて腔所を再現した積層造形モデルを積層造形するためのデータを生成する（データ生成行程）
ST1
データを積層造形が可能な状態に用意する（準備工程）
ST2
腔所を再現した積層造形モデルを積層造形を経て作製する（積層造形行程）
ST3
積層造形モデルの周囲を成形材料で満たした後、成形材料を硬化させて立体モデルを形成する（形成行程）
積層造形モデルの溶出方式は？
加熱による溶融による
溶剤による溶解による
加熱による溶融と溶剤による溶解との併用による
ST4a
加熱により積層造形モデルを溶融し立体モデルの外部へ溶出する（溶出工程）
ST4b
溶剤により積層造形モデルを溶融し立体モデルの外部へ溶出する（溶出工程）
ST4c
加熱による溶融と溶剤による溶解とを併用することによって積層造形モデルを立体モデルの外部へ溶出する（溶出工程）

【図８】



【図９】



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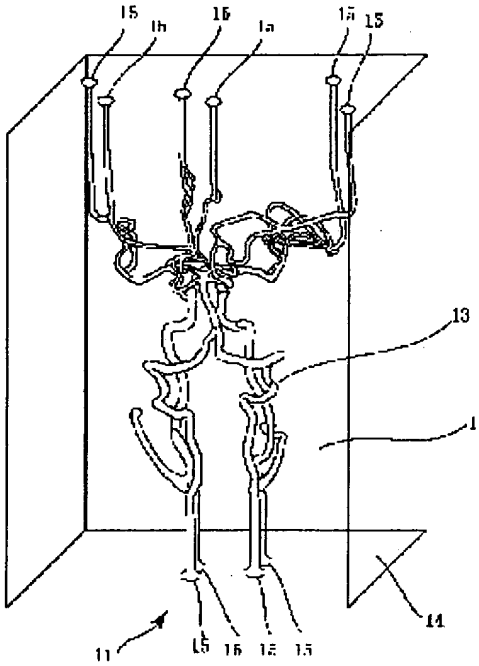
(54) METHOD FOR MANUFACTURING THREE-DIMENSIONAL MODEL WITH CAVITY REPRODUCED THEREIN, AND THREE-DIMENSIONAL MODEL WITH CAVITY REPRODUCED THEREIN



(57)Abstract:

PROBLEM TO BE SOLVED: To enable, in manufacturing a three-dimensional model with cavities existing in a human body reproduced therein based on data, use of a diversified range of materials and to enable manufacture in a short period of time irrespec tive of the shaping volume of the three-dimensional model.

SOLUTION: A laminate shaping model with the cavities reproduced therein is manufactured by carrying out laminate shaping based on data, and the periphery thereof is filled with a molding material. After the molding material is hardened, the laminate shaping model is eluted out from the inside to the outside of the three-dimensional model formed by the hardening of the molding material. Thus, unlike the three-dimensional model directly shaped by laminate shaping, the three-dimensional model can be manufactured using a diversified range of materials which cannot be used in laminate shaping and in a short period of time irrespective of the shaping volume.

CLAIMS

[Claim(s)]

[Claim 1] By being eluted, the laminating molding model reproducing the cavity which exists in the body It is the approach of obtaining the solid model which formed the cavity which has the same configuration as this laminating molding model, and reproduced said cavity inside by this, and is (a). The preparation stroke which prepares the data for carrying out laminating molding of the laminating molding model reproducing a cavity, (b) The laminating molding stroke which produces said laminating molding model through laminating molding using said data, (c) The formation stroke which is made to harden this molding material and forms a solid model after filling with a molding material the perimeter of said laminating molding model

obtained in the laminating molding stroke, (d) The manufacture approach of the solid model which reproduced the cavity to the interior characterized by having the elution stroke eluted to the exterior of the solid model fuses said laminating molding model with heating, and pass hardening of said molding material in the formation stroke.

[Claim 2] By being eluted, the laminating molding model reproducing the cavity which exists in the body It is the approach of obtaining the solid model which formed the cavity which has the same configuration as this laminating molding model, and reproduced said cavity inside by this, and is (a). The preparation stroke which prepares the data for carrying out laminating molding of the laminating molding model reproducing a cavity, (b) The laminating molding stroke which produces said laminating molding model through laminating molding using said data, (c) The formation stroke which is made to harden this molding material and forms a solid model after filling with a molding material the perimeter of said laminating molding model obtained in the laminating molding stroke, (d) The manufacture approach of the solid model which reproduced the cavity to the interior characterized by having the elution stroke eluted to the exterior of the solid model dissolves said laminating molding model with a solvent, and pass hardening of said molding material in the formation stroke.

[Claim 3] By being eluted, the laminating molding model reproducing the cavity which exists in the body It is the approach of obtaining the solid model which formed the cavity which has the same configuration as this laminating molding model, and reproduced said cavity inside by this, and is (a). The preparation stroke which prepares the data for carrying out laminating molding of the laminating molding model reproducing a cavity, (b) The laminating molding stroke which produces said laminating molding model through laminating molding using said data, (c) The formation stroke which is made to harden this molding material and forms a solid model after filling with a molding material the perimeter of said laminating molding model obtained in the laminating molding stroke, and (d) By using together melting by heating, and the dissolution by the solvent The manufacture approach of the solid model which reproduced the cavity to the interior characterized by having the elution stroke eluted in said laminating molding model to the exterior of the solid model pass hardening of said molding material in the formation stroke.

[Claim 4] The manufacture approach of the solid model which reproduced the cavity to the interior characterized by to have the data generation stroke which generates said data further prepared for the interior of a publication at said preparation process in the manufacture approach of the solid model reproducing a cavity at either of claim 1 to claims 3 based on photography by photography equipment before said preparation process.

[Claim 5] In the manufacture approach of the solid model which reproduced the cavity inside the publication to either of claim 1 to claims 4 further the line after said elution stroke As a stroke which intervenes in the middle of said elution stroke, it sets in said elution stroke. The manufacture approach of the solid model which reproduced the cavity to the interior characterized by having the diffusion removal stroke which the component of the component of said laminating molding model diffused inside said solid model is evaporated by heating said solid model, and removes it from the interior of said solid model.

[Claim 6] The manufacture approach of the solid model which reproduced a cavity to the interior characterized by to produce said laminating molding model through laminating molding of a method which carries out a laminating at the same time it forms a sintering hardening layer and carries out sequential formation of this sintering hardening layer by scanning laser at a powder-like ingredient [molding] top in the manufacture approach of the solid model which reproduced the cavity inside the publication to either of claim 1 to claims 5.

[Claim 7] In the manufacture approach of the solid model which reproduced the cavity inside the publication to either of claim 1 to claims 5 Making the molding ingredient which carried out heating fusion spouted or dropped, and solidifying it from a nozzle, make a nozzle head scan and a thin layer is formed. The manufacture approach of the solid model which reproduced the cavity to the interior characterized by producing said laminating molding model through laminating molding of a method which carries out a laminating at the same time it carries out sequential formation of this thin layer.

[Claim 8] In the manufacture approach of the solid model which reproduced the cavity inside the publication to either of claim 1 to claims 5 Making it extrude and solidify from a nozzle so that a molding ingredient may be extruded and the molding ingredient of the shape of this thin line may be drawn from a nozzle The manufacture approach of the solid model which reproduced the cavity to the interior characterized by producing said laminating molding model through laminating molding of a method which carries out a laminating at the same time it forms a thin layer and carries out sequential formation of this thin layer by making a nozzle head scan.

[Claim 9] It is the solid model which reproduced the cavity inside, and is (a). The solid model formation part formed of hardening of a molding material, and (b) Solid model which reproduced the cavity to the interior characterized by having the cavernous part formed by eluting a laminating molding model through melting by heating.

[Claim 10] It is the solid model which reproduced the cavity inside, and is (a). The solid model formation part formed of hardening of a molding material, and (b) Solid model which reproduced the cavity to the interior characterized by having the cavernous part formed by eluting a laminating molding model through the dissolution by the solvent.

[Claim 11] It is the solid model which reproduced the cavity inside, and is (a). The solid model formation part formed of hardening of a molding material, and (b) Solid model which reproduced the cavity to the interior characterized by using together melting by heating, and the dissolution by the solvent, and having the cavernous part formed by eluting a laminating molding model.

[Claim 12] The solid model which is a solid model which reproduced the cavity inside the publication to either of claim 9 to claims 11, and reproduced the cavity to the interior characterized by having transparency after said molding material's hardening.

[Claim 13] The solid model which is a solid model which reproduced the cavity to the interior according to claim 12, and reproduced the cavity to the interior characterized by having at least one flat surface in the external configuration of said solid model.

[Claim 14] The solid model which is a solid model which reproduced the cavity inside the publication to either of claim 9 to claims 13, and reproduced the cavity to the interior characterized by using silicone rubber (a silicone elastomer or silicone gel) for said all or a part of solid model formation part.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Field of the Invention] This invention produces the laminating molding model reproducing the configuration of a cavity by laminating molding in more detail about the solid model which reproduced the cavity which exists in the body inside, and its manufacture approach, and relates to the solid model obtained by ** which is eluted in this and forms a cavity, and its manufacture approach.

[0002]

[Description of the Prior Art] In the field of current and medical equipment, various kinds of photography equipments, such as an X-ray CT scanner, MRI equipment, and an ultrasonic device, are used as a universality technique for the purpose of inspection of various kinds of illnesses in many organs of the body, or pregnancy, or a diagnosis.

[0003] According to these photography equipments, it is possible to photo the interior of the body by non-invasion. Medical practitioners conventionally Vacate spacing with photography equipment, perform 2-dimensional photography, and by arranging continuously the 2-dimensional image of two or more sheets generated based on the obtained 2-dimensional data etc. The three-dimensions configuration of a photography field was imagined and it has performed grasping relative-position relation with the focus, an organ, etc. which become important in the case of an operation. However, generally it is not easy to

understand the three-dimensional structure of the management circumference by such approach.

[0004] According to the X-ray CT scanner of a helical scan which appeared in recent years, it is possible to photo three dimensions to the body, and the three-dimensions data inside the body can be directly obtained by this. And **** which can also generate the three dimensional image of a photography field by performing reconstruction by the computer with progress of a digital-image-processing technique etc. based on said 2-dimensional data obtained by photography equipment, or said three-dimensions data. Furthermore, various techniques, such as performing a coloring display for every generating and displaying the 2-dimensional image of the cross section of arbitration to the generated three dimensional image or changing and displaying a view, organ, or organization, were developed, and those use also became possible. And it became possible to grasp to accuracy the image information obtained by photography more easily and more by using these environments, and the environment for grasping the three-dimensional structure inside the body improved by leaps and bounds.

[0005] However, it is impossible to actually take in its hand the model which the information shown by these approaches was not still different from the former, and made the image the subject, for example, was obtained, to actually try an operation using the obtained model, etc. depending on these approaches.

[0006] Current and laminating molding which is spreading quickly are spreading quickly also in the medical world as epoch-making equipment which fills such a demand.

[0007] There are various laminating molding methods including the Mitsuzo form in laminating molding. This laminating molding is the technique of molding the three-dimensions molding object which has a desired three-dimensions configuration, by carrying out a laminating at the same time it carries out sequential formation of the thin layer based on data. According to this laminating molding, it is possible to reappear to a precision as a solid model based on the 2-dimensional image and three dimensional image which were obtained by said photography equipment which has the same configuration for a part [object].

[0008] JP,5-11689,A proposes the manufacture approach of such a solid model by laminating molding. This invention offers the approach of manufacturing the solid model which has the same configuration as many organs made into an object, by performing laminating molding according to the Mitsuzo form which is a kind of laminating molding based on the 2-dimensional image of two or more sheets obtained by taking a photograph at equal intervals with photography equipment. According to this invention, it is possible to include to that internal configuration and to reappear faithfully as a solid model by any parts, by low invasion or non-invasion, as long as sufficient image information is obtained, without having effect on a pain or the body.

[0009]

[Problem(s) to be Solved by the Invention] Especially in the solid model of internal organs or organs as which the manufacture approach is proposed by JP,5-11689,A, the reproducing-to precision-configuration of whole target part chief aim is not placed, and emphasis is not necessarily put on reproducing the cavity which exists in the body. However, in various fields, such as operation trial which actually uses medical equipment besides grasp of the configuration of a cavity, or structure, various use is possible for the solid model reproducing the cavity which exists in the body, and it is very useful to manufacture such a solid model.

[0010] the molding ingredient for which it depended on the property of the laminating molding system used for laminating molding at manufacture of this solid model like JP,5-11689,A on the other hand when a solid model was manufactured by laminating molding -- not using it -- it does not obtain but the degree of freedom of ingredient selection is very low. And in the present condition, it is difficult or impossible for the molding ingredient equipped with high transparency, for example, the molding ingredient equipped with sufficient flexibility to reproduce body tissue, etc. to hardly exist, but to manufacture a solid model with those properties therefore. Moreover, by laminating molding which molds a solid model, the duration over molding increases by leaps and bounds with the increment in the molding volume of a solid model, improvement in molding precision, etc. by carrying out the laminating of the very thin molding layer. Therefore, by the approach proposed by JP,5-11689,A, in molding a solid model with the big molding volume directly by laminating molding, it is obliged to spend long duration on molding of a solid model.

[0011] For this reason, the solid model and list which reproduced the cavity which was constituted with ingredients other than the molding ingredient depending on the property of the laminating molding system used for laminating molding, and which exists in the body inside are expected to obtain the manufacturing technology for manufacturing, without increasing the duration over molding by leaps and bounds with this solid model to the increment in the molding volume, improvement in molding precision, etc.

[0012]
[Objects of the Invention] This invention is made in view of the above-mentioned technical problem. The purpose The solid model which was constituted with ingredients other than the molding ingredient depending on the property of the laminating molding system used for laminating molding and which reproduced the cavity which exists in the body inside, It is in obtaining the manufacturing technology for manufacturing, without increasing the duration over molding by leaps and bounds with this solid model to the increment in the molding volume, improvement in molding precision, etc.
[0013]
[A terminological definition] Each vocabulary in this specification is defined as follows.
[0014] A "cavity" is vocabulary which names generically the dead air space which exists in the body, and points out the dead air space constituted by geometry, such as these many organs, body walls, etc., to the dead air space which exists in many organs (a frame, a muscle, a circulatory organ, a breather, a digestive organ, a urination reproductive organ, an endocrine organ, a nerve, sensor, etc.), and a list. Therefore, the lumen of many organs, such as the lumen of the heart, a stomach lumen, an intestinal lumen, a lumen of a uterus, a lumen of a blood vessel, and a lumen of a ureter, the oral cavity, a nasal cavity, fauces, a middle ear cavity, a coelome, the cavum articulare, a pericardium, etc. are contained in a "cavity."
[0015] pass laminating molding with a "laminating molding model" -- the vocabulary which points out the produced three-dimensions molding object -- it is -- therefore -- laminating molding -- pass a series of molding strokes including laminating molding, without being limited to the three-dimensions molding object therefore produced independently -- the produced three-dimensions molding object is also included.
[0016] A "solid model" is vocabulary which points out only the model reproducing a cavity to the interior obtained by this invention, and it is distinguished from the "three dimensional object model" used when pointing out the model of other general solid configurations in this specification. Therefore, although the model obtained by laminating molding is contained in a "three dimensional object model", it is not contained in a "solid model."
[0017] "Photography equipment" is vocabulary which names generically the equipment which can acquire the data about the cavity which exists in the body by taking a photograph, and the X-ray plant (an X-ray CT scanner is included) of various methods, MRI equipment, an ultrasonic device, etc. are contained in "photography equipment."
[0018] A "molding material" is vocabulary which hardens and names an usable ingredient generically to shaping of a three-dimensions molding object using this property.
[Means for Solving the Problem]
[0019] In order to attain the above-mentioned purpose, in invention of claim 1 By being eluted, the laminating molding model reproducing the cavity which exists in the body It is the approach of obtaining the solid model which formed the cavity which has the same configuration as this laminating molding model, and reproduced said cavity inside by this, and is (a). The preparation stroke which prepares the data for carrying out laminating molding of the laminating molding model reproducing a cavity, (b) The laminating molding stroke which produces said laminating molding model through laminating molding using said data, (c) The formation stroke which is made to harden this molding material and forms a solid model after filling with a molding material the perimeter of said laminating molding model obtained in the laminating molding stroke, (d) Said laminating molding model is fused with heating, and it is characterized by having the elution stroke eluted to the exterior of the solid model pass hardening of said molding material in the formation stroke.

[0020] Invention of claim 2 the laminating molding model reproducing the cavity which exists in the body moreover, by being eluted It is the approach of obtaining the solid model which formed the cavity which has the same configuration as this laminating molding model, and reproduced said cavity inside by this, and is (a). The preparation stroke which prepares the data for carrying out laminating molding of the laminating molding model reproducing a cavity, (b) The laminating molding stroke which produces said laminating molding model through laminating molding using said data, (c) The formation stroke which is made to harden this molding material and forms a solid model after filling with a molding material the perimeter of said laminating molding model obtained in the laminating molding stroke, (d) Said laminating molding model is dissolved with a solvent, and it is characterized by having the elution stroke eluted to the exterior of the solid model pass hardening of said molding material in the formation stroke.
[0021] Invention of claim 3 the laminating molding model reproducing the cavity which exists in the body moreover, by being eluted It is the approach of obtaining the solid model which formed the cavity which has the same configuration as this laminating molding model, and reproduced said cavity inside by this, and is (a). The preparation stroke which prepares the data for carrying out laminating molding of the laminating molding model reproducing a cavity, (b) The laminating molding stroke which produces said laminating molding model through laminating molding using said data, (c) The formation stroke which is made to harden this molding material and forms a solid model after filling with a molding material the perimeter of said laminating molding model obtained in the laminating molding stroke, and (d) By using together melting by heating, and the dissolution by the solvent It is characterized by having the elution stroke eluted in said laminating molding model to the exterior of the solid model pass hardening of said molding material in the formation stroke.
[0022] Invention of claim 4 is characterized by having the data generation stroke which generates said data further prepared for the interior of a publication at said preparation process in the manufacture approach of the solid model reproducing a cavity at either of claim 1 to claims 3 based on photography by photography equipment before said preparation process.
[0023] In the manufacture approach of a solid model that invention of claim 5 reproduced the cavity inside the publication to either of claim 1 to claims 4 further the line after said elution stroke It is characterized by having the diffusion removal stroke which the component of said laminating molding model diffused inside said solid model in said elution stroke as a stroke which intervenes in the middle of said elution stroke is evaporated by heating said solid model, and removes it from the interior of said solid model.
[0024] Invention of claim 6 is characterized by to produce said laminating molding model through laminating molding of a method which carries out a laminating at the same time it forms a sintering hardening layer and carries out sequential formation of this sintering hardening layer by scanning laser at a powder-like ingredient [molding] top in the manufacture approach of the solid model which reproduced the cavity inside the publication to either of claim 1 to claims 5.
[0025] It carries out that invention of claim 7 produces said laminating molding model through laminating molding of a method which carries out a laminating at the same time it makes a nozzle head scan, it forms a thin layer and it carries out sequential formation of this thin layer, make the molding ingredient which carried out heating fusion from the nozzle spouted or dropped, and solidify it in the manufacture approach of the solid model which reproduced the cavity inside the publication to either of claim 1 to claims 5 as the description.
[0026] In the manufacture approach of a solid model that invention of claim 8 reproduced the cavity inside the publication to either of claim 1 to claims 5 Making it extrude and solidify from a nozzle so that a molding ingredient may be extruded and the molding ingredient of the shape of this thin line may be drawn from a nozzle It is characterized by producing said laminating molding model through laminating molding of a method which carries out a laminating at the same time it forms a thin layer and carries out sequential formation of this thin layer by making a nozzle head scan.
[0027] Invention of claim 9 to claim 14 has the advantage of the solid model which reproduced the cavity to the interior manufactured by such manufacture approach.

[0028] Among these, the solid model which reproduced the cavity inside invention of claim 9 is (a). The solid model formation part formed of hardening of a molding material, and (b) It is characterized by having the cavernous part formed by eluting a laminating molding model through melting by heating.
[0029] Moreover, the solid model which reproduced the cavity inside invention of claim 10 is (a). The solid model formation part formed of hardening of a molding material, and (b) It is characterized by having the cavernous part formed by eluting a laminating molding model through the dissolution by the solvent.
[0030] Moreover, the solid model which reproduced the cavity inside invention of claim 11 is (a). The solid model formation part formed of hardening of a molding material, and (b) It is characterized by using together melting by heating, and the dissolution by the solvent, and having the cavernous part formed by eluting a laminating molding model.
[0031] The solid model which reproduced the cavity inside invention of claim 12 is a solid model which reproduced the cavity inside the publication to either of claim 9 to claims 11, and is characterized by having transparency, after said molding material's hardening.
[0032] The solid model which reproduced the cavity inside invention of claim 13 is a solid model which reproduced the cavity to the interior according to claim 12, and is characterized by having at least one flat surface in the external configuration of said solid model.
[0033] The solid model which reproduced the cavity inside invention of claim 14 is a solid model which reproduced the cavity inside the publication to either of claim 9 to claims 13, and is characterized by using silicone rubber (a silicone elastomer or silicone gel) for said all or a part of solid model formation part.
[0034]
[Embodiment of the Invention] Hereafter, this invention is explained to a detail based on an accompanying drawing.
[0035] A whole [that drawing 1 showed 1 of the operation of the laminating / having reproduced a cavity / that laminating molding produces a whole / having shown 1 of the operation of a solid / having reproduced a cavity inside / model gestalt / perspective view and drawing 2 / molding model of this invention gestalt] perspective view and drawing 3 are important section [showing the cross-section structure at the time of having produced a laminating / having reproduced a cavity / show in drawing 2 / molding model as the structure of hollow] cross-section expansion perspective views. Drawing 4 to drawing 8 is the flow chart which explained the outline as one step about the manufacture approach of the solid model which reproduced the cavity inside this invention as, respectively as each manufacture line, and the flow chart of drawing 8 supports the manufacture approach of the solid model which reproduced the cavity from claim 1 to the interior according to claim 5 from drawing 4 , respectively. In addition, the same step number is used for the stroke which is mutually common in each of these drawings.
[0036] Below, the manufacture approach of the solid model which reproduced the cavity inside this invention is explained to a detail based on an accompanying drawing.
[0037] The solid model which reproduced the cavity inside this invention (a) The preparation stroke which prepares the data for carrying out laminating molding of the laminating molding model reproducing a cavity, (b) The laminating molding stroke which produces said laminating molding model through laminating molding using said data, (c) The formation stroke which is made to harden this molding material and forms a solid model after filling with a molding material the perimeter of said laminating molding model obtained in the laminating molding stroke, (d) It is manufactured by the manufacture approach characterized by having the elution stroke eluted in said laminating molding model to the exterior of the solid model pass hardening of said molding material in the formation stroke. Furthermore, by the manufacture approach according to claim 4, it has the data generation process which generates said data prepared at said preparation process based on photography by photography equipment before said preparation process. Moreover, as a stroke which intervenes in the middle of the stroke after said elution stroke, or said elution stroke, by heating said solid model, the component of the component of said laminating molding model diffused inside said solid model in said elution stroke is evaporated, and it has the diffusion removal stroke removed from the interior of said solid model by the manufacture approach according to claim 5.

[0038] Below, each production process concerning manufacture of the solid model which reproduced the cavity inside this invention is explained to a detail, making it contrast with each step shown in the flow chart of drawing 8 from drawing 4 .

[0039] <A. data generation stroke> The manufacture approach of the solid model which reproduced the cavity to the interior according to claim 4 is characterized by having the data generation process which generates the data (data for carrying out laminating molding of the laminating molding model reproducing a cavity) prepared at a preparation process based on photography by photography equipment. Below, the operation gestalt of this data generation process is explained in full detail. This data generation process corresponds to the step ST 0 of the flow chart shown in drawing 7 and drawing 8 .

[0040] In order to generate the data prepared at a preparation process based on photography by photography equipment, the 2-dimensional image of the target body or a three dimensional image is first obtained with photography equipments, such as an X-ray CT scanner and MRI equipment. What can obtain only a 2-dimensional image, and the thing which can obtain a three dimensional image exist in photography equipment according to a class. Since the image information of the three dimensions about said cavity is needed for generation of said data, to use the photography equipment with which only a 2-dimensional image is obtained, it is necessary to obtain two or more 2-dimensional images by taking a photograph by changing a camera station. In addition, what is necessary is just to make a change of a camera station by the parallel displacement. The image information of the three dimensions needed for generation of said data is obtained by being able to photo two or more 2-dimensional images at regular intervals or arbitration spacing, and carrying out the laminating of the obtained 2-dimensional image based on photography spacing by this. However, what is necessary is just to make a change of a camera station freely, without being based on a parallel displacement, as long as the image information of sufficient three dimensions is obtained (migration of a camera station in the direction of arbitration, or rotation of bearing of the exposure axis). Moreover, you may use combining the 2-dimensional image and three dimensional image which were obtained by two or more photography equipments. In addition, in order to link with the precision of reappearance of a cavity configuration directly, it is necessary to adjust appropriately photography spacing (photography consistency) of a 2-dimensional image according to the precision of reappearance needed.

[0041] Next, available typical photography equipment is explained to photography of these 2-dimensional images and a three dimensional image. However, there are various things besides the equipment explained below in photography equipment, and this invention is not limited to these photography equipments.

[0042] As an X-ray CT scanner, perform photography by the X-ray from all the directions of [on the horizontal same cross section of the body], and by computer-processing the acquired information Moving the target body besides [which obtains the 2-dimensional image of a photography cross section] the X-ray CT scanner of the conventional method in the direction of a body axis On the other hand, by performing spiral roentgenography and computer-processing the three-dimensions information on the body obtained by this by taking a photograph, rotating an X-ray detection device in a flat surface perpendicular to a body axis There is an X-ray CT scanner of the helical scan which can obtain a three dimensional image and the 2-dimensional image in an arbitration cross section etc. Furthermore, by building the X-ray detection device of many trains in the interior of equipment, two or more coincidence photography is enabled and the thing of a multi-slice method which realized improvement in spatial resolving power, compaction of exposure time, etc. by this also exists in the X-ray CT scanner of a helical scan.

[0043] MRI equipment is equipment using the nuclear-magnetic-resonance phenomenon of the hydrogen atom which constitutes the great portion of body, and this phenomenon images the condition of an organization based on being influenced by the difference in the environment the amount of a hydrogen atom, and around a hydrogen atom included in body tissue. According to this equipment, it is possible to obtain the 2-dimensional image of an arbitration cross section, without changing the location of the target body, and it is also possible to obtain the 2-dimensional image of many cross sections to coincidence further. This MRI equipment has an advantage in respect of the ability to carry out the photography photography of that soft tissue can be photoed by high contrast, the blood vessel surrounded by the osseous tissue since it was not

influenced of the osseous tissue vividly compared with an X-ray CT scanner.

[0044] Next, the data (following and three-dimensions configuration data) about the three-dimensions configuration of the cavity made into the object of solid modeling are generated based on these 2-dimensional images and three dimensional images that were obtained by photography equipment. Although carried out by using the software which makes this possible, a series of processings concerning generation of this three-dimensions configuration data may use two or more software in that process, when single software cannot perform all processings. In addition, in current, two or more marketing is carried out and the software which performs processing of these single strings automatically may use those software.

[0045] based on the 2-dimensional image (two or more sheets need) or three dimensional image obtained by photography equipment, various approaches as a well-known technique have already exist in the approach of generate the three dimensions configuration data of the specific part in a photography field, and although one gestalt of those approaches be mention and explain in full detail here since it be difficult to explain all approaches in full detail, this invention be limit to the operation gestalt describe below.

[0046] Although the case where two or more 2-dimensional images obtained by taking a photograph at equal intervals are used as an input image is explained, even when using as an input image here the 2-dimensional image obtained by other photography approaches, or a three dimensional image, carrying out a parallel displacement in the direction of a body axis, the three-dimensions configuration data of a cavity can be obtained by performing same processing. Based on photography spacing at the time of photography, the laminating of the inputted 2-dimensional each image is carried out correctly first. Next, by specifying the threshold about an image concentration value on a 2-dimensional each image, only the cavity field made into the object of solid modeling is extracted from the inside of a 2-dimensional each image, and other fields are deleted by one side from the inside of the 2-dimensional image by which the laminating was carried out. It is given in the form where the three-dimensions configuration of the part which is equivalent to said cavity field by this carried out the laminating of the 2-dimensional image, and the border line of this 2-dimensional each image is interpolated in three dimensions, and the three-dimensions configuration data of the target cavity are generated by reconfigurating as a three-dimensions curved surface. In addition, although the cavity field was first extracted from the inside of an input image by specifying the threshold about a concentration value in this case, it is also possible by a cavity front face's extracting and carrying out three-dimensions interpolation from the inside of an input image, to generate a three-dimensions curved surface directly by specifying the specific concentration value which gives a cavity front face apart from this approach. Moreover, after performing the field extract (or surface extract by specific concentration value assignment) by threshold assignment, the laminating of an input image may be performed. Moreover, polygon approximation may perform generation of a three-dimensions curved surface.

[0047] In addition, to said three-dimensions configuration data, it is possible to perform correction and modification of a configuration during generation of these three-dimensions data or after generation. adding the structure not existing into the image data obtained by photography, or for example, adding the supporting structure called a support -- or it is possible to remove a part of structure in said image data, to change the configuration of a cavity, etc., and the configuration of the cavity formed in the interior of the solid model 11 of this can be corrected or changed freely. Furthermore, it is also possible to establish a non-laminating molding field in the interior of a cavity, and the interior explained later is made into structure in the air, and in producing the laminating molding model which formed the non-laminating molding field 31, it generates the three-dimensions data which established such a non-laminating molding field 31 in the interior of a cavity. In addition, these processings may be performed in the software corresponding to a laminating molding system or a laminating molding system.

[0048] Next, the three-dimensions configuration data of the generated cavity are sent to the software corresponding to the laminating molding system used changing into the format corresponding to the laminating molding system used for laminating molding of the laminating molding model 21 if needed, or the laminating molding system to be used.

[0049] By the laminating molding system (or software corresponding to a laminating molding system), a

support adds a support (supporting structure) to a required part for the purpose, such as configuration maintenance under laminating molding, at the same time it sets up various setting items, such as arrangement of the laminating molding model 21 at the time of laminating molding, and the direction of a laminating, (if unnecessary, it is not necessary to add). The slice data directly used for laminating molding are generated by slicing the data for molding obtained by doing in this way by the last based on the molding thickness at the time of laminating molding. In addition, contrary to the above-mentioned procedure, a support may be added, after generating slice data. Moreover, when automatically generated by the laminating molding system (or software corresponding to a laminating molding system) which slice data use, it is not necessary to generate slice data. However, a setup of laminating molding thickness is needed in that case. When the same is said of addition of a support and a support is automatically generated by the laminating molding system (or software corresponding to a laminating molding system), it is not necessary to generate manually (you may generate manually).

[0050] <B. preparation process> A preparation process the data for carrying out laminating molding of the laminating molding model 21 reproducing the cavity made into the object of solid modeling It prepares for direct laminating molding in the same gestalt as the data obtained as the last gestalt of the above-mentioned data generation process as available data (it is hereafter called laminating molding data), and it is the stroke with which laminating molding is equipped, and corresponds to the step ST 1 of the flow chart shown in drawing 8 from drawing 4 R> 4. However, this preparation process is a stroke with which prepares laminating molding data and laminating molding is equipped, and is not a stroke which generates laminating molding data (no process about generation of laminating molding data is included in this preparation process).

[0051] <C. laminating molding stroke> A laminating molding stroke is a stroke produced by laminating molding using said laminating molding data prepared in said preparation process in said laminating molding model 21 reproducing the configuration of the cavity made into the object of solid modeling, and corresponds to the step ST 2 of the flow chart shown in drawing 8 from drawing 4 . Below, the operation gestalt of this laminating molding stroke is explained in full detail.

[0052] The laminating molding model 21 reproducing the cavity produced by laminating molding is used as a disappearance model for ROSUTO waxes in a next process. The disappearance model for ROSUTO waxes is the model originally used by the precision casting called ROSUTO wax casting, and after coating and calcinating the perimeter of this model with refractories and ceramic refractories of a particle, it is used by melting and removing this model in order to manufacture the mold for casting the casting which has the same configuration as said disappearance model. However, in this invention, said laminating molding model 21 produced by laminating molding is not used for the purpose of the aforementioned mold manufacture. After forming the solid model 11 by filling the particular part of the whole perimeter or a perimeter, and stiffening this molding material with a molding material, the laminating molding model 21 which exists in the solid model 11 interior -- (a) the heating scorification fused with heating -- or (b) the solvent solution process which dissolves with a solvent -- or (c) By fluidizing alternatively and being eluted to the exterior of the solid model 11 by applying whether it is the hybrid method and ******** which use together melting by heating, and the dissolution by the solvent It is used in order to manufacture the solid model 11 which has a cavity with the same configuration thru/or the structure as the target cavity inside. In addition, in heating scorification, a solvent solution process corresponds to claim 2, and a hybrid method corresponds to claim 1 at claim 3, respectively.

[0053] Therefore, in this invention, the following constraints which have relation mutually are imposed depending on any shall be used between the aforementioned heating scorification, a solvent solution process, and a hybrid method between the ingredient (it is hereafter called a molding ingredient) used for laminating molding of the laminating molding model 21, and the ingredient (it is hereafter called a molding material) used for shaping of the solid model 11.

[0054] (1) To perform elution of the laminating molding model 21 with said heating scorification, it is necessary to fulfill the constraint of both the following (1-1) and (1-2).

(1-1) Fuse said molding ingredient with heating.
(1-2) Said molding material can be hardened in temperature lower than the melting temperature of a molding ingredient given in a constraint (1-1), and has heat-resistant temperature higher than the melting temperature of the molding ingredient of a publication in a constraint (1-1) after hardening.
[0055] (2) To perform elution of the laminating molding model 21 with said solvent solution process, it is necessary to fulfill the constraint of both the following (2-1) and (2-2).
(2-1) Said molding ingredient dissolves in a solvent (such a solvent exists).
(2-2) Said molding material has solvent resistance among the solvents of a publication to at least one kind of solvent (it is hereafter called a specific solvent) in a constraint (2-1).
[0056] (3) To perform elution of the laminating molding model 21 with said hybrid method, it is necessary to fulfill the constraint of both the following (3-1) and (3-2).
(3-1) Fuse said molding ingredient with heating, and it dissolves in a solvent (such a solvent exists).
(3-2) While said molding material can be hardened in temperature lower than the melting temperature of a molding ingredient given in a constraint (3-1) and it has heat-resistant temperature higher than the melting temperature of the molding ingredient of a publication in a constraint (3-1) after hardening, it has solvent resistance to at least one kind of solvent (specific solvent) among the solvents of a publication in a constraint (3-1).
[0057] In addition, in case it fills the perimeter of this laminating molding model with said molding material in the following formation stroke, as long as it is range which has the reinforcement which can bear external force, such as a pressure added from the outside, said laminating molding model 21 makes the interior hollow structure, by establishing the non-laminating molding field 31 in the interior, may carry out the thinning of the appearance side, and may produce it. The cost accompanying the time amount and molding by which necessary is carried out to laminating molding is not only reduced by this, but by it, the easy elution of the laminating molding model 21 becomes possible in a next elution stroke. However, the interior is made into structure in the air, and in order to mold the laminating molding model which equipped the interior with the non-laminating molding field 31, the laminating molding data prepared in a previous preparation stroke need to be generated so that this molding may be performed.
[0058] Laminating molding of for example, a powder sintering method, laminating molding of a melting resin jet method, laminating molding of a melting resin extrusion method, etc. are mentioned to laminating molding which enables use of the molding ingredient with which are satisfied of the constraint concerning the above-mentioned heating scorification, a solvent solution process, or a hybrid method. Below, these various laminating molding methods are explained in full detail. However, laminating molding concerning the manufacture approach of this invention is not limited to these methods.
[0059] In laminating molding of a powder sintering method, by scanning beams for heating, such as laser, on the powder ingredient laid by the plane based on said laminating molding data, melting of the powdered front face is carried out, powder is joined, and the sintered powder thin layer is formed. Junction to the lower layer thin film already sintered at this time is also performed to coincidence. Next, laminating molding of the laminating molding model 21 is performed by performing laminating molding of a method which carries out a laminating at the same time the thin layer of new powder is again supplied to a top face, repeats this stroke and carries out sequential formation of the powder sintering layer.
[0060] In laminating molding of a melting resin multiaxial type, making a nozzle head scan on a flat surface based on said laminating molding data, laminating molding of the laminating molding model 21 is performed by performing laminating molding of a method which carries out a laminating at the same time make the molding ingredient fused from the nozzle spouted or dropped, it carries out deposition solidification, it forms a thin layer and it carries out sequential formation of this thin layer.
[0061] In laminating molding of a melting resin extrusion mold, a molding ingredient is extruded from a thin nozzle, a thin layer is formed by making a nozzle head scan on a field based on said laminating molding data, making it send out and solidify from a nozzle so that the ingredient of the shape of this thin line may be drawn, and laminating molding of the laminating molding model 21 is performed by performing laminating

molding of the method which carries out the laminating of this.

[0062] In addition, it is possible to add various kinds of processings (removal processing and addition processing), such as surface polish and addition of surface coating, to the laminating molding model 21 produced by laminating molding after laminating molding, and it is possible to correct or change the configuration of the laminating molding model 21 by this. The support is removed when the removal after laminating molding adds a required support in production of the laminating molding model 21 as part of these processings.

[0063] <D. formation stroke> After a formation stroke fills with a molding material the perimeter of said laminating molding model 21 obtained in the laminating molding stroke, it is a stroke which is made to harden this molding material and forms the solid model 11, and corresponds to the step ST 3 of the flow chart shown in drawing 8 from drawing 4 . Below, the operation gestalt of this formation stroke is explained in full detail.

[0064] Formation of the solid model 11 around the laminating molding model 21 produced in said laminating molding stroke (1) The molding material with which it is satisfied of said constraint (1-2) when using heating scorification in a next elution stroke, (2) The molding material with which it is satisfied of said constraint (2-2) when using a solvent solution process in a next elution stroke, and (3) or [filling with the molding material with which it is satisfied of said constraint (3-2) in using a hybrid method] -- or after covering, it carries out by stiffening this molding material. in addition -- if the dies body of the request configuration prepared beforehand is used in case the perimeter of the laminating molding model 21 is filled with a molding material -- being good (the interior of this dies body being filled with said laminating molding model 21 and molding material) -- do not use a dies body, but the molding material of the shape of a sol or powder is made to adhere to the front face of the laminating molding model 21, and the solid model 11 may be formed by stiffening this (dipping shaping, slush molding). When using a dies body, it is desirable to prepare for removal of a next dies body and to use an ingredient with a low affinity with said molding material to be used. However, it is good also as some solid models 11 which do not remove a dies body but are finally obtained.

[0065] In addition, when fabricating the external configuration of the solid model 11 by the dies body, it is possible to reproduce both external configurations, such as many organs which carry out entailment of a cavity and this cavity, by making the cavity for the configuration of the shaping side of a dies body in agreement with external configurations, such as many organs which carry out entailment.

[0066] However, the external configuration of the solid model 11 does not need to make the target cavity in agreement with external configurations, such as many organs which carry out entailment, and may be replaced in other configurations (for example, cube configuration etc.). For example, when manufacturing the solid model 11 using the molding material which has transparency, the recognition nature of the cavity reproduced inside this solid model can be raised by establishing a flat surface 14 in the external configuration of this solid model.

[0067] Moreover, to the external configuration of the solid model 11, various kinds of removal processing and addition processings may be performed after formation by hardening of a molding material, it can graduate by this or correction and modification can be added to a configuration.

[0068] <E. elution process> Next, the operation gestalt of the eluted elution stroke which is eluted in the laminating molding model 21 to the exterior of said solid model obtained in the formation stroke with said heating scorification, said solvent solution process, or said hybrid method is explained in full detail. It has the elution stroke characterized by eluting claim 1, claim 2, and claim 3 in a laminating molding model using said heating scorification, said solvent solution process, and said hybrid method, respectively. The elution stroke which distinguished these from drawing 4 with the flow chart shown in drawing 8 , and used said heating scorification corresponding to claim 1 Step ST4a, It wrote step ST4c [the elution stroke using said hybrid method corresponding to step ST4b and claim 3 for the elution stroke using said solvent solution process corresponding to claim 2].

[0069] After forming the solid model 11 by stiffening a molding material, while removing said dies body, the

laminating molding model 21 is eluted and removed to the exterior of the solid model 11 with said heating scorification, said solvent solution process, or said hybrid method. What is necessary is not to limit this invention to this sequence and just to carry out removal of a garbage in order of arbitration, although described on explanation below in order of removal of a dies body, and elution ** of the laminating molding model 21. That is, it is in the middle of removing a dies body after removal of the laminating molding model 21, and removal of the laminating molding model 21, and it is possible to remove a dies body (the laminating molding model 21 or in the middle of removal of a dies body removal), to remove the laminating molding model 21 and a dies body by turns gradually, etc.

[0070] Removal of a dies body is performed by the predetermined removal approach. However, removal is unnecessary when using a dies body as some solid models 11.

[0071] Removal of the laminating molding model 21 from the solid model 11 interior is performed with the aforementioned heating scorification, a solvent solution process, or a hybrid method. Below, each approach is explained. In addition, although elution of the laminating molding model 21 is performed from the elution part 15 which the laminating molding model 21 exposed from the solid model 11, when such an elution part 15 does not exist, it performs removal processing to a case in part to the front face of the solid model 11, and forms the elution part 15 of the laminating molding model 21 in it. In addition, this removal processing may be performed before melting of the laminating molding model 21, or the dissolution, and melting or after dissolving, it may perform the laminating molding model 21.

[0072] By fusing alternatively the laminating molding model 21 which exists in the solid model 11 interior, and fluidizing it with heating, heating scorification is an approach of removing by carrying out elution, and the application is more possible for it than the solid model 11 interior only within the case where both said constraint (1-1) and (1-2) are satisfied.

[0073] The laminating molding model 21 of the solid model 11 interior is fused alternatively, and is made to fluidize in this heating scorification by heating first to temperature higher [than the melting temperature of the molding ingredient of the laminating molding model 21] and lower than the heat-resistant temperature of the molding material of the solid model 11 after hardening. If the laminating molding model 21 responds in order of the solid model 11 and dies body removal before elution, it is in the condition of having been united with the dies body, but when both said constraint (1-1) and (1-2) are satisfied, it is possible by heating such whole structure or a part with a heater etc. to fuse the laminating molding model 21 alternatively. In addition, it is also possible to also perform heating of the solid model 11 from the solid model exterior and to heat from the interior of a solid model by irradiating the exterior to to arrange a heating electrode inside a solid model and a laminating molding model, laser, etc., although it is possible etc. Next, it removes by carrying out elution of the laminating molding model 21 to the exterior of the solid model 11 in this condition. Although the inertia generated by giving remote force, such as gravity and a centrifugal force, an impact, and vibration can be used at the time of the elution of this laminating molding model 21, it is also possible to promote elution by applying external pressure (positive pressure, negative pressure) to the part which the laminating molding model 21 exposed, or slushing other liquids into the interior of a cavity. Moreover, the laminating molding model 21 (some laminating molding models 21 which remained to the solid model 11 interior especially after elution) of the solid model 11 interior may be eliminated to the exterior of the solid model 11 in the condition of solid phase by applying direct external force, giving an impact and vibration, or grasping directly etc. Under the present circumstances, the laminating molding model 21 of the solid model 11 interior may be disassembled into two or more parts.

[0074] Into the molding ingredient of the laminating molding model 21 which enables application of this heating solution process Various kinds of thermoplastics (thermoplastic) (what has a high (the viscosity at the time of melting is low) fluidity at the time of melting is desirable) and waxes (fats and oils, paraffin, etc.), Or various ingredients can be used as long as it fuses in temperature lower than the heat-resistant temperature of the molding material used for formation of the solid model 11 besides being a low-melt point point metal, ice(water), etc. In addition, it is necessary to opt for selection of these molding ingredients according to the property of the molding material used for the solid model 11 (a molding material may be

chosen according to the property of a molding ingredient).

[0075] By dissolving alternatively and fluidizing with a solvent, the laminating molding model 21 which exists in the solid model 11 interior, a solvent solution process is an approach of removing by carrying out elution, and the application is more possible for it than the solid model 11 interior only within the case where both said constraint (2-1) and (2-2) are satisfied.

[0076] It dissolves alternatively and the laminating molding model 21 of the solid model 11 interior is made to fluidize in this solvent solution process by using the specific solvent first given according to said constraint (2-2). Although it is in the condition of having been united with the dies body if the laminating molding model 21 responds in order of the solid model 11 and dies body removal before elution When both said constraint (2-1) and (2-2) are satisfied, it is possible to dissolve the laminating molding model 21 alternatively by contacting the part containing the part which such whole structure or the laminating molding model 21 exposed to said specific solvent. Next, it removes by carrying out elution of the laminating molding model 21 to the exterior of the solid model 11 in this condition. It is also possible to promote elution by being able to use the inertia generated by giving remote force, such as gravity and a centrifugal force, an impact, and vibration as well as the case of heating scorification, applying external pressure (positive pressure, negative pressure) to the part which the laminating molding model 21 exposed, or slushing other liquids into the interior of a cavity etc. at the time of the elution of this laminating molding model 21. Moreover, the laminating molding model 21 (some laminating molding models 21 which remained to the solid model 11 interior especially after elution) of the solid model 11 interior may be eliminated to the exterior of the solid model 11 in the condition of solid phase by applying direct external force, giving an impact and vibration, or grasping directly etc. Under the present circumstances, the laminating molding model 21 of the solid model 11 interior may be disassembled into two or more parts.

[0077] Into the molding ingredient of the laminating molding model 21 which enables application of this solvent solution process, use of the various resin which has soluble agent solubility, such as adhesion matter, such as cyanoacrylate (it dissolves in an acetone) and starch (it dissolves in water etc.), and toluenesulfonamide resin (it dissolves in an acetone etc.), polyvinyl alcohol (it dissolves in water etc.), waxes (fats and oils, paraffin, etc.), etc. is possible. In addition, when enforcing a solvent solution process, selection of the molding ingredient which the molding material used for the solid model 11 needs to have solvent resistance to the solvent used for the dissolution of the laminating molding model 21, and uses for the laminating molding model 21 is good to determine according to the property of the molding material used for the solid model 11 (a molding material may be chosen according to the property of a molding ingredient).

[0078] By using together the heating scorification and the solvent solution process which were explained in full detail previously, a hybrid method is an approach of removing by carrying out elution of the laminating molding model 21 which exists in the solid model 11 interior from the solid model 11 interior, and the application is possible for it only within the case where both said constraint (3-1) and (3-2) are satisfied.

[0079] this hybrid method -- (1) The stroke eluted in the laminating molding model 21 from the solid model 11 interior with heating, and (2) a solvent -- by carrying out the stroke eluted in the laminating molding model 21 from the solid model 11 interior in order of arbitration, said laminating molding model 21 is removed from the solid model 11 interior (or thing done for the multiple-times operation of each process in the sequence of arbitration). Below, each of these processes are explained in full detail.

[0080] (1) Fuse alternatively the laminating molding model 21 of the solid model 11 interior, and make it fluidize by heating the laminating molding model 21 from the solid model 11 interior first in the eluted stroke with heating to temperature higher [than the melting temperature of the molding ingredient of the laminating molding model 21] and lower than the heat-resistant temperature of the molding material of the solid model 11 after hardening. If the laminating molding model 21 responds in order of the solid model 11 and dies body removal before elution, it is in the condition of having been united with the dies body, but when both said constraint (3-1) and (3-2) are satisfied, it is possible by heating such whole structure or a part with a heater etc. to fuse the laminating molding model 21 alternatively. In addition, it is also possible to also perform heating of the solid model 11 from the solid model exterior and to heat from the interior of a solid

model by irradiating the exterior to to arrange a heating electrode inside a solid model and a laminating molding model, laser, etc., although it is possible etc. Next, it removes by carrying out elution of the laminating molding model 21 to the exterior of the solid model 11 in this condition. Although the inertia generated by giving remote force, such as gravity and a centrifugal force, an impact, and vibration can be used at the time of the elution of this laminating molding model 21, it is also possible to promote elution by applying external pressure (positive pressure, negative pressure) to the part which the laminating molding model 21 exposed, or slushing other liquids into the interior of a cavity etc. Moreover, the laminating molding model 21 (some laminating molding models 21 which remained to the solid model 11 interior especially after elution) of the solid model 11 interior may be eliminated to the exterior of the solid model 11 in the condition of solid phase by applying direct external force, giving an impact and vibration, or grasping directly etc. Under the present circumstances, the laminating molding model 21 of the solid model 11 interior may be disassembled into two or more parts.

[0081] (2) Dissolve alternatively and make the laminating molding model 21 of the solid model 11 interior fluidize by using the specific solvent first given according to said constraint (3-2) in the stroke eluted in the laminating molding model 21 from the solid model 11 interior with a solvent. Although it is in the condition of having been united with the dies body if the laminating molding model 21 responds in order of the solid model 11 and dies body removal before elution When both said constraint (3-1) and (3-2) are satisfied, it is possible to dissolve the laminating molding model 21 alternatively by contacting the part containing the part which such whole structure or the laminating molding model 21 exposed to said specific solvent. Next, it removes by carrying out elution of the laminating molding model 21 to the exterior of the solid model 11 in this condition. It is also possible to promote elution by being able to use the inertia generated by giving remote force, such as gravity and a centrifugal force, an impact, and vibration as well as the point, applying external pressure (positive pressure, negative pressure) to the part which the laminating molding model 21 exposed, or slushing other liquids into the interior of a cavity etc. at the time of the elution of this laminating molding model 21. Moreover, the laminating molding model 21 (some laminating molding models 21 which remained to the solid model 11 interior especially after elution) of the solid model 11 interior may be eliminated to the exterior of the solid model 11 in the condition of solid phase by applying direct external force, giving an impact and vibration, or grasping directly etc. Under the present circumstances, the laminating molding model 21 of the solid model 11 interior may be disassembled into two or more parts.

[0082] It is possible to carry out multiple-times operation of each process for each above-mentioned process in the sequence of arbitration in a hybrid method if needed. For example, after being eluted from the solid model 11 interior in most laminating molding models 21 by making the laminating molding model 21 fuse and fluidize from heating, By pouring in the specific solvent given to the cavernous field of the solid model 11 interior which cooled the solid model 11 to the room temperature, and was formed of previous elution according to said constraint (3-2) Some laminating molding models 21 which remained to the solid model 11 interior with surface tension etc. are fluidized again, and it is possible to be eluted to the exterior of the solid model 11 with the poured-in solvent etc.

[0083] As a molding ingredient of the laminating molding model 21 which enables application of this hybrid method, the ingredient which enables application of the both sides of said heating solution process and said solvent solution process can be used, and thermoplastics (thermoplastic), such as toluenesulfonamide resin, and use of waxes (fats and oils, paraffin, etc.) etc. are possible.

[0084] According to the heating scorification and the hybrid method which perform melting of the laminating molding model 21 with heating It is possible for it not to be based on the exposure product of the laminating molding model 21, but to fuse and fluidize the whole laminating molding model in non-contact with advance of the thermal diffusion to the solid model 11 interior. When dissolving the laminating molding model 21 gradually from a surface of action by physical contact like a solvent solution process, it is possible to reproduce easily the cavity of a complicated configuration which is difficult elution, for example, the shape of a high capillary which is an aspect ratio, etc.

[0085] giving direct external force to the laminating molding model 21 from an exposed part besides these

approaches, although the approach eluted from the interior of the solid model 11 in the laminating molding model 21 with heating scorification, a solvent solution process, and a hybrid method was explained above, giving impulse force, vibration, etc. from the exterior of the solid model 11, grasping directly, etc. -- etc. -- it is also more possible than the solid model 11 interior to eliminate the laminating molding model 21. Moreover, in this case, the laminating molding model 21 of the solid model 11 interior may be disassembled into two or more parts, and each decomposed part may be taken out from the solid model 11 interior. In addition, when removing the laminating molding model 21 by this approach, it is possible by producing the laminating molding model 21 by making the interior hollow to easy-ize disassembly of the laminating molding model 21. However, application is difficult, when this approach has the complicated configuration of the laminating molding model 21, or when it has the high configuration whose laminating molding model 21 is an aspect ratio.

[0086] The solid model 11 which reproduced the cavity inside divides into plurality the cavity made into the object of solid modeling. By producing the solid model which reproduced each cavity inside by enforcing the manufacture approach of this invention to each divided cavity, and combining the solid model to each obtained cavity It is also possible to obtain the solid model 11 reproducing the whole cavity made into the object of solid modeling. In this case, the solid model to each cavity can also be respectively manufactured by the different manufacture approach. However, this invention also makes the object of invention the solid model to each cavity divided into plurality, and its manufacture approach.

[0087] <F. diffusion removal stroke> The manufacture approach of the solid model which reproduced the cavity to the interior according to claim 5 As a stroke which intervenes in the middle of the stroke after an elution stroke, or an elution stroke It is characterized by having the diffusion removal stroke which the component of said molding ingredient diffused inside said solid model in the elution stroke is evaporated by heating a solid model again, and removes it from the interior of a solid model. Below, the operation gestalt of this diffusion removal stroke is explained in full detail. In distinction from drawing 8 (a) and drawing 8 (b), the flow chart was shown, respectively by whether this diffusion removal stroke is carried out as a stroke after an elution stroke, or it carries out as a stroke which intervenes in the middle of an elution stroke. In the flow chart of drawing 8 (a), a diffusion removal stroke corresponds to ST5. On the other hand, in the flow chart of drawing 8 (b), the diffusion removal stroke and the elution stroke were shown as one step, and it distinguished as step ST6a, step ST6b, and step ST6c, respectively by using any of said heating scorification, said solution method for solvents, and said hybrid method an elution stroke is carried out.

[0088] The solid model 11 formed of hardening of a molding material in the formation stroke When constituted by the ingredient which has the elasticity of silicone rubber etc. especially, When the laminating molding model 21 is fused with heating in an elution stroke, a part of component (it is hereafter called a diffusion component) of the molding ingredient which constitutes the laminating molding model 21 may be spread inside the solid model 11, and dyeing etc. may be generated in the solid model 11 interior.

[0089] When the laminating molding model 21 is fused with heating, a part of component (it is hereafter called a diffusion component) of the molding ingredient which constitutes the laminating molding ingredient 21 evaporates this diffusion (evaporation), and it originates in being spread to the solid model 11 interior, and is generated. In many cases (except for the case where a diffusion component combines with the component and chemistry target of the solid model 11 etc.), what (it is made to evaporate) is evaporated again is possible for this diffusion component that remained to the solid model 11 interior after the elution of the laminating molding model 21 by heating the solid model 11 again. Since a part of diffusion component evaporated inside the solid model 11 is discharged by diffusion from the solid model 11 interior in the exterior of the solid model 11, it can remove a diffusion component from the solid model 11 interior by this. By cooling, the all deposit to the part, and deposit to a solid model front face depending on the case, and the diffusion component furthermore evaporated inside the solid model 11 removes a diffusion component from the solid model 11 interior by it being also more possible than the solid model 11 interior to remove a diffusion component, and using these approaches in a diffusion removal stroke by this. In addition, when using crosslinked polymer, such as an elastomer, as a molding material, it is possible by using it, choosing

the high ingredient of crosslinking density to heighten the effectiveness of the diffusion removal by these approaches.

[0090] Moreover, it is able to remove or discolor dyeing produced by diffusion by this for heating to be able to decompose the diffusion component of the solid model 11 interior, especially coloring matter, etc. in many cases. However, it is necessary to perform heating of the solid model 11 within limits lower than the heat-resistant temperature of the ingredient which constitutes the solid model 11, and in this temperature requirement, this approach can be applied, only when decomposition of a diffusion component is possible.

[0091] As mentioned above, according to the manufacture approach of the solid model of this invention, it is possible to manufacture the solid model which is a short time and reproduced the target cavity inside based on the data for carrying out laminating molding of the laminating molding model 21 of the target cavity. Moreover, the cavity of a complicated configuration can also be reappeared easily. moreover, the solid model which reproduced the affected part etc. for every patient by manufacturing a solid model by the manufacture approach according to claim 4 -- a short time -- and it is supposed that it is possible to manufacture in low invasion or non-invasion in the target body, and it is also possible to use the manufactured solid model for the plan before an operation and the operation trial before an operation.

[0092] <Solid model which reproduced the cavity inside G.> Below, the solid model which reproduced the cavity inside this invention is explained to a detail based on one gestalt of operation shown in an accompanying drawing.

[0093] The solid model which reproduced the cavity inside this invention is (a). The solid model formation part formed of hardening of a molding material, and (b) It is characterized by having the cavernous part formed by eluting a laminating molding model. The solid model which reproduced the cavity to the interior according to claim 9 carries out the description of being formed, when said cavernous part dissolves a laminating molding model with heating and is eluted. The solid model which reproduced the cavity to the interior according to claim 10 carries out the description of being formed, when said cavernous part dissolves a laminating molding model with a solvent and is eluted. Moreover, the solid model which reproduced the cavity to the interior according to claim 11 is characterized by being formed, when said cavernous part uses together melting by heating, and the dissolution by the solvent and is eluted in a laminating molding model.

[0094] [0095] hereafter explained using a drawing The solid model 11 is equipped with the solid model formation part 12 formed of hardening of a molding material, and the cavernous part 13 formed by eluting the laminating molding model 21.

[0096] [whether among this, the solid model formation part 12 fills the perimeter of the laminating molding model 21 with a molding material, and] After making the molding material of the shape of a sol or powder adhere to the perimeter of the **** laminating molding model 21, it is the part formed by stiffening a molding material. The external configuration When fabricating by making a molding material adhere without a dies body, and hardening in accordance with the configuration of the shaping side of a dies body, in fabricating using a dies body, it is decided with the configuration (volume) change property at the time of hardening of a molding material etc. that they will be the condition of the molding material at the time of molding material adhesion and a list.

[0097] The external configuration of the solid model 11 may be formed as the same configuration as external configurations, such as many organs which may form as configurations of arbitration, such as the shape of the shape of a cylindrical shape, or a globular form, or carry out entailment of the target cavity, without being limited to a cube configuration. Moreover, by making a molding material adhere to the perimeter of the laminating molding model 21, and making it harden, you may form as a configuration of the shape of the shape of a thin film, and thin meat with fixed thickness.

[0098] In order to reproduce the elasticity which a body tissue has as a molding material which can be used for the solid model formation part 12, it is desirable to use the ingredient which has high resiliency, such as an elastomer. However, using the ingredient which has high resiliency may use common molding materials, such as resin, rather than it is indispensable. As a molding material which can be used for the solid model formation part 12, it is independent, or two or more thermosetting resin, such as silicone resin besides

elastomers, such as silicone rubber (a silicone elastomer, silicone gel) and a thermosetting polyurethane elastomer, or gel, an epoxy resin, polyurethane, unsaturated polyester, phenol resin, and a urea resin, and thermoplastics, such as a polymethyl methacrylate, can be used, for example, combining them. In addition, molding materials, such as these elastomers, resin, etc. (1) What [is reacted chemically and hardened at a room temperature by adding a catalyst, a curing agent, etc.] (catalyst hardening or polyol hardening) (2) What (moisture hardening) reacts chemically at a room temperature with moisture, and is hardened, and (3) What (oxidation hardening) reacts chemically at a room temperature by oxidation, and is hardened, and (4) By heating Or what (heat hardening) is reacted chemically and hardened by heating after adding a catalyst, a curing agent, etc. and (3) What is hardened by two or more approaches among (1) to (4) can be used.

[0099] After the cavernous part's 13 having filled the perimeter of the laminating molding model 21 with the molding material or making the molding material of the shape of a sol or powder adhere to the perimeter of the **** laminating molding model 21, It is the part formed by eluting the previous laminating molding model 21 from the interior of the solid model formation part 12 formed by stiffening a molding material, and is the part formed when surrounded by the inner surface of the solid model formation part 12.

[0100] Although this cavernous part 13 is a part reproducing the cavity made into the object of solid modeling and is characterized by having the same three-dimensions configuration substantially with the three-dimensions configuration of the cavity made into the object of solid modeling, the three-dimensions configuration of the cavity made into the object of solid modeling and its three-dimensions configuration of this cavernous part 13 do not need to be completely the same. That is, correction and modification may be added to the configuration, it may originate in the precision of configuration reappearance being low, and both configurations may differ. In addition, the cavity made into the object of solid modeling may be a cavity (or thing which added correction and modification based on it) which exists in the body (a living body or body) which exists, and may be a cavity obtained data and based on knowledge. Moreover, the cavity made into the object of solid modeling may be a cavity which exists in the body of animals other than human being besides the cavity which exists in human being's body.

[0101] In the cavity which exists in human being's body, for example, the lumen of the heart, a stomach lumen, an intestinal lumen, The oral cavity constituted by geometry, such as these many organs besides the lumen of many organs, such as a lumen of a uterus, a lumen of a blood vessel, and a lumen of a ureter, and a body wall, There are a nasal cavity, fauces, a middle ear cavity, a coelome, cavum articulare, a pericardium, etc., and the three-dimensions configuration of the cavernous part 13 can be made into the configuration which reproduced the three-dimensions configuration of these cavities, for example.

[0102] The ingredient which has transparency after hardening may be used for the molding material used for the solid model formation part 12. There are thermosetting resin, such as silicone resin besides elastomers, such as silicone rubber (a silicone elastomer, silicone gel) and a thermosetting polyurethane elastomer, or gel, an epoxy resin, polyurethane, unsaturated polyester, phenol resin, and a urea resin, thermoplastics, such as a polymethyl methacrylate, etc. in the molding material in which the kind which has transparency exists. By forming the solid model formation part 12 using the molding material which has such transparency, the solid model 11 excellent in the recognition nature of the cavernous part 13 reproducing a cavity which exists in the interior can be obtained.

[0103] Moreover, it is possible to establish a flat surface 14 in the external configuration of the solid model formation part 12, i.e., the external configuration of the solid model 11. When fabricating the external configuration of a solid model using a dies body, such a flat surface 14 can be formed by establishing a flat surface on the shaping side of the dies body to be used, and after it forms the solid model formation part 12 by hardening of a molding material, it can also be formed by performing various kinds of removal processing and addition processings. In the flat-surface 14 top established by establishing a flat surface 14 in the external configuration of the solid model 11, since the direction of optical refraction over parallel light can be arranged uniformly, when the solid model formation part 12 is especially formed with the molding material which has transparency, the solid model excellent in the recognition nature of the cavernous part 13 reproducing a cavity which exists in the solid model 11 interior can be obtained. Moreover, by establishing a

flat surface 14 in the pars basilaris ossis occipitalis of the solid model 11, when putting a solid model on an even location, stability improves.

[0104] The cavernous part 13 reproducing a cavity has the perimeter surrounded by the inner surface of the solid model formation part 12. It is also possible to insert a medical device etc. and to use for trial of an operation etc., when aiming at such use, it is desirable [the inner surface of the solid model formation part 12] to present the contact property similar to the inner surfaces, such as many organs which carry out entailment of the cavity, therefore as for the solid model 11 of this invention, it is desirable to use the molding material which can reproduce contact properties, such as resiliency which a body tissue has, good for the solid model formation 12. Silicone rubber (a silicone elastomer or silicone gel) is suitable for reproducing the resiliency which is excellent in resiliency and a body tissue has. Moreover, since broad grade exists about resiliency (hardness), it is possible to choose the grade which has the optimal resiliency according to the property of the cavity made into the object of solid modeling. Furthermore, generally silicone rubber (a silicone elastomer or silicone gel) shows non-adhesiveness, is excellent also in surface lubricity by using lubricant, and very suitable for reproducing many physical properties which a body tissue has. Therefore, the solid model which reproduced even contact properties, such as resiliency which not only the configuration of the target cavity but a body tissue has, good can be obtained by forming the solid model formation part 12 using silicone rubber (a silicone elastomer or silicone gel). Moreover, since the kind which has very high transparency also exists in silicone rubber (a silicone elastomer or silicone gel), it is also possible by forming the solid model formation part 12 using silicone rubber (a silicone elastomer or silicone gel) excellent in such transparency to obtain the solid model excellent in the recognition nature of the cavernous part 13 reproducing a cavity which exists in the solid model 11 interior. Moreover, generally, silicone rubber (a silicone elastomer or silicone gel) is inactive chemically, and since it excels also in weatherability (chemical resistance) and thermal resistance, it also fits especially implementation of the manufacture approach of the solid model which reproduced the cavity inside this invention.

[0105] The solid model which reproduced the cavity inside this invention In the medical field, by for example, the thing reproducing the configurations of the affected part or the affected part, and its boundary region It is supposed that it is possible medical practitioners not only can to grasp intuitively the three-dimensions configuration and structure of the affected part and affected part circumference correctly, but to actually insert various kinds of medical equipments, such as a catheter and an endoscope, in the cavernous part which reproduced the cavity inside a solid model further, and to use for trial of an operation etc. The solid model which reproduced the blood vessel lumen which has many diseases, such as an aneurysm, and the vasoconstriction section or the thrombus section, as an example of operation trial is used. By inserting a catheter, an aneurysm plug way, a vasodilatation way and a stent placement way, The solid model reproducing the stomach lumen which has many diseases, such as trying operations, such as an artery lock out way, gastric cancer, and an esophagus cancer, an esophageal lumen, or the large intestine lumen which has colon cancer and a polyp of colon is used. It is possible by inserting an endoscope to try the operation to excision, such as cancer and a polyp. Such operation trial can be carried out to various parts, such as a nasal cavity, an ear space, the abdominal cavity, and a uterus.

[0106] Thus, in the medical field, it is very useful as an auxiliary means for raising the result of training sharply in order use for the purpose which grasps a configuration, a condition, etc. of the affected part or its circumference part is possible for the solid model which reproduced the cavity inside this invention and also to carry out smoothly the operation which requires an advanced technique and skill. Moreover, use of the solid model which reproduced the cavity inside this invention can be used in various fields, such as the educational fields, such as the science educational field and the medical indoctrination field, without being limited to the medical field.

[0107]

[Example] Although an example is given and this invention is explained concretely hereafter, this invention is not limited only to these examples and does not need to pass through all the processes indicated on the occasion of actual operation. generation of the data for carrying out laminating molding of the laminating

molding model 21 in [the example 1] especially -- Seki -- although the process corresponding to claim 4 is also described the bottom, there is a process which generates the data for carrying out laminating molding of the laminating molding model 21 out of range [a preparation process according to claim 3], and it is not necessary to necessarily carry it out from claim 1

[0108] [Example 1] A photograph was first taken to a patient's head with the X-ray CT scanner with spatial resolving power of 0.35x0.35x0.5mm of a helical scan, medicating the interior of a blood vessel of a photography field with a contrast medium, in order to obtain the three-dimensions data about the configuration of the cerebral blood vessel made into the object of solid modeling, and the **** artery which it reaches and is the affected part. After reconfigurating the three-dimensions data obtained by photography in the 2-dimensional image of 256 gradation which has the resolution of 512x512 of 500 sheets arranged at equal intervals in the direction of a body axis for delivery to three-dimensional-CAD software, they saved the image data corresponding to a 2-dimensional each image to the 5.25 inch magneto-optic disk by the drive built in said X-ray CT scanner in the sequence which is in agreement with bearing of the exposure axis.

[0109] Next, said image data was incorporated to the store inside a computer in the personal computer by the 5.25 inch light MAG drive which made external connection, and the three dimensions configuration data of the STL format (format which expresses a three dimensions curved surface as an aggregate of a triangle patch) needed for laminating molding were generated from this image data using commercial 3-dimensional CAD software. By carrying out the laminating of the inputted 2-dimensional image in this conversion based on photography spacing By building the scalar field of the three dimensions which make a concentration value scalar quantity, and specifying the specific concentration value which gives a blood vessel internal surface on the scalar field After building the three-dimensions configuration data of a blood vessel lumen as AISO surface (interface of a specific scalar value), the rendering of triangle polygon approximation is performed to the built AISO surface.

[0110] The three-dimensions configuration data of the generated STL format were transmitted to the laminating molding system of a melting resin jet method next, and while determining the arrangement and the direction of a laminating of the model within a molding system, and laminating thickness, the support was added to the model. Thus, the generated data for laminating molding were sliced in laminating molding thickness (13 micrometers) predetermined in a computer top, and much slice data were generated. and the thing to do for the whole surface [every] laminating formation of the resin hardening layer of the assignment thickness which have the configuration which be in agreement with each slice data by fuse with heating the molding ingredient (melting point : dissolve in an acetone easily about 100 degrees) an ingredient used p - toluenesulfonamide and a p - ethylbenzene sulfonamide as a principal component, and spout based on each slice data obtained by do in this way -- laminating molding be performed. By removing a support after formation of the last layer, the laminating molding model of a cerebral blood vessel lumen field was created.

[0111] On the other hand, the dies body used in order to fabricate the external configuration of the solid model 11 was created by machining. The internal shaping side of this dies body is carrying out the cube configuration, and assembly and separation are possible for the member which constitutes a dies body. After having arranged the laminating molding model 21 created by the laminating molding system inside this dies body for cast molding, when both were fixed, the mold was created by pasting up the edge of a model on a dies body inside.

[0112] thus, the liquid silicone elastomer of a 2 liquid hybrid model with the high transparency in which polymerization hardening in a short time by heating is possible inside the created mold -- slushing -- 75-degree C constant temperature -- by heating within a layer for 1 hour, polymerization hardening was carried out and the solid model was formed. And after checking that sufficient hardening had been obtained, sequential separation was carried out and the member which constitutes a dies body was removed.

[0113] thus, the solid model 11 of the acquired cube configuration -- 120-degree C constant temperature -- by heating within a layer for 1 hour, the laminating molding model 21 which exists in the interior of the solid model 11 was fused, and elution was performed to the exterior of the solid model 11. In addition, the edge of

the laminating molding model 21 performed this elution from the part exposed from the solid model 11. The whole block was cooled to the room temperature after the elution of the molding ingredient by heating melting, and the acetone was poured into the cavernous section formed in the interior of the solid model 11 of the elution of a laminating molding model. Thereby, the molding ingredient which remained to the solid model 11 interior was dissolved, and the solution-ized molding ingredient was eluted to the exterior of a solid model. Thereby, the laminating molding model 21 was completely removed from the solid model 11 interior, and the solid model which reproduced the cerebral blood vessel lumen inside was obtained.

[0114] the constant temperature again set as 120 degrees C in order to, eliminate the component of said molding ingredient diffused inside the solid model 11 at the time of melting of the laminating molding model 21 more nearly finally than the interior of the solid model 11 -- said solid model 11 was heated within the layer for 1 hour, said component was evaporated, and this removed.

[0115] Thus, the solid model 11 of the produced cerebral blood vessel lumen was that the configuration of the cerebral blood vessel lumen reproduced by the solid model 11 interior, structure, and the configuration of the cerebral aneurysm reproducing the affected part are recognized to be easily and correctly by viewing by having used the highly transparent silicone elastomer for the molding material by having high transparency and having established the flat surface 14 by making an external configuration into a cube configuration further. Furthermore, the solid model of the produced cerebral blood vessel was what presents the insertion feeling very just like the time of an actual cerebral blood vessel operation, and actuation feeling to insertion of the catheter which is pouring a lubricant into the interior and is a medical device. Drawing 1 and drawing 2 show the laminating molding model of the cerebral blood vessel lumen field produced by the schematic diagram and laminating molding system of a solid model of the cerebral blood vessel lumen finally manufactured by operation of this invention, respectively.

[0116]

[Effect of the Invention] Since the cavity of the same configuration as this laminating molding model is formed by eluting the laminating molding model produced by laminating molding based on data according to the approach of one invention of claim 1 to claims 3 as explained above, the cavity of an arbitration configuration is reproducible to a precision by generating said data based on the configuration of a cavity. Moreover, unlike the case where a direct solid model is molded by laminating molding, by laminating molding, a solid model can be manufactured with the various ingredients which cannot be used. Furthermore, according to these approaches, since a solid model is formed of hardening of a molding material, unlike the case where a direct solid model is molded, generally, it cannot be based on the molding volume but can obtain a solid model by laminating molding in a short time. Consequently, with various ingredients, the solid model which reproduced the cavity of an arbitration configuration inside cannot be twisted for the molding volume, but can be manufactured and obtained in a short time.

[0117] Moreover, according to the approach of invention of claim 4, since the data for carrying out laminating molding of the laminating molding model reproducing a cavity are generated based on photography by photography equipment, they can be obtained by low invasion or non-invasion to the target body [data / these]. Consequently, the solid model which reproduced the target cavity inside by low invasion or non-invasion to the target body can be obtained.

[0118] Moreover, according to the approach of invention of claim 5, the component of the molding ingredient of the laminating molding model diffused inside the solid model in the elution stroke is evaporated, and this can remove from the interior of a solid model. Consequently, said component can obtain the solid model removed completely in part.

[0119] Moreover, according to the approach of one invention of claim 6 to claims 8, it is possible to perform laminating molding using the molding ingredient both melting by heating, the dissolution by the solvent, or whose dissolution by melting by heating and the solvent is enabled, and the laminating molding model which contains this molding ingredient as a component can be produced. Consequently, the produced laminating molding model can be eluted from the interior of a solid model, and the solid model which reproduced the cavity inside can be obtained.

[0120] Moreover, one invention of claim 9 to claims 11 has the advantage that the cavity of an arbitration configuration is reproducible inside, as a solid model which reproduced the cavity to the interior manufactured by the above-mentioned all directions method invention.
[0121] Moreover, invention of claim 12 or claim 13 has the advantage of excelling in the recognition nature of the cavity reproduced inside as a solid model which reproduced the cavity to the interior manufactured by the above-mentioned all directions method invention.
[0122] Moreover, invention of claim 14 has the advantage of having flexibility, as a solid model which reproduced the cavity to the interior manufactured by the above-mentioned all directions method invention.

TECHNICAL FIELD

[Field of the Invention] This invention produces the laminating molding model reproducing the configuration of a cavity by laminating molding in more detail about the solid model which reproduced the cavity which exists in the body inside, and its manufacture approach, and relates to the solid model obtained by ** which is eluted in this and forms a cavity, and its manufacture approach.

PRIOR ART

[Description of the Prior Art] In the field of current and medical equipment, various kinds of photography equipments, such as an X-ray CT scanner, MRI equipment, and an ultrasonic device, are used as a universality technique for the purpose of inspection of various kinds of illnesses in many organs of the body, or pregnancy, or a diagnosis.
[0003] According to these photography equipments, it is possible to photo the interior of the body by non-invasion. Medical practitioners conventionally Vacate spacing with photography equipment, perform 2-dimensional photography, and by arranging continuously the 2-dimensional image of two or more sheets generated based on the obtained 2-dimensional data etc. The three-dimensions configuration of a photography field was imagined and it has performed grasping relative-position relation with the focus, an organ, etc. which become important in the case of an operation. However, generally it is not easy to understand the three-dimensional structure of the management circumference by such approach.
[0004] According to the X-ray CT scanner of a helical scan which appeared in recent years, it is possible to photo three dimensions to the body, and the three-dimensions data inside the body can be directly obtained by this. And **** which can also generate the three dimensional image of a photography field by performing reconstruction by the computer with progress of a digital-image-processing technique etc. based on said 2-dimensional data obtained by photography equipment, or said three-dimensions data. Furthermore, various techniques, such as performing a coloring display for every generating and displaying the 2-dimensional image of the cross section of arbitration to the generated three dimensional image or changing and displaying a view, organ, or organization, were developed, and those use also became possible. And it became possible to grasp to accuracy the image information obtained by photography more easily and more by using these environments, and the environment for grasping the three-dimensional structure inside the body improved by leaps and bounds.
[0005] However, it is impossible to actually take in its hand the model which the information shown by these approaches was not still different from the former, and made the image the subject, for example, was obtained, to actually try an operation using the obtained model, etc. depending on these approaches.
[0006] Current and laminating molding which is spreading quickly are spreading quickly also in the medical world as epoch-making equipment which fills such a demand.

[0007] There are various laminating molding methods including the Mitsuzo form in laminating molding. This laminating molding is the technique of molding the three-dimensions molding object which has a desired three-dimensions configuration, by carrying out a laminating at the same time it carries out sequential formation of the thin layer based on data. According to this laminating molding, it is possible to reappear to a precision as a solid model based on the 2-dimensional image and three dimensional image which were obtained by said photography equipment which has the same configuration for a part [object].

[0008] JP,5-11689,A proposes the manufacture approach of such a solid model by laminating molding. This invention offers the approach of manufacturing the solid model which has the same configuration as many organs made into an object, by performing laminating molding according to the Mitsuzo form which is a kind of laminating molding based on the 2-dimensional image of two or more sheets obtained by taking a photograph at equal intervals with photography equipment. According to this invention, it is possible to include to that internal configuration and to reappear faithfully as a solid model by any parts, by low invasion or non-invasion, as long as sufficient image information is obtained, without having effect on a pain or the body.

EFFECT OF THE INVENTION

[Effect of the Invention] Since the cavity of the same configuration as this laminating molding model is formed by eluting the laminating molding model produced by laminating molding based on data according to the approach of one invention of claim 1 to claims 3 as explained above, the cavity of an arbitration configuration is reproducible to a precision by generating said data based on the configuration of a cavity. Moreover, unlike the case where a direct solid model is molded by laminating molding, by laminating molding, a solid model can be manufactured with the various ingredients which cannot be used. Furthermore, according to these approaches, since a solid model is formed of hardening of a molding material, unlike the case where a direct solid model is molded, generally, it cannot be based on the molding volume but can obtain a solid model by laminating molding in a short time. Consequently, with various ingredients, the solid model which reproduced the cavity of an arbitration configuration inside cannot be twisted for the molding volume, but can be manufactured and obtained in a short time.

[0117] Moreover, according to the approach of invention of claim 4, since the data for carrying out laminating molding of the laminating molding model reproducing a cavity are generated based on photography by photography equipment, they can be obtained by low invasion or non-invasion to the target body [data / these]. Consequently, the solid model which reproduced the target cavity inside by low invasion or non-invasion to the target body can be obtained.

[0118] Moreover, according to the approach of invention of claim 5, the component of the molding ingredient of the laminating molding model diffused inside the solid model in the elution stroke is evaporated, and this can remove from the interior of a solid model. Consequently, said component can obtain the solid model removed completely in part.

[0119] Moreover, according to the approach of one invention of claim 6 to claims 8, it is possible to perform laminating molding using the molding ingredient both melting by heating, the dissolution by the solvent, or whose dissolution by melting by heating and the solvent is enabled, and the laminating molding model which contains this molding ingredient as a component can be produced. Consequently, the produced laminating molding model can be eluted from the interior of a solid model, and the solid model which reproduced the cavity inside can be obtained.

[0120] Moreover, one invention of claim 9 to claims 11 has the advantage that the cavity of an arbitration configuration is reproducible inside, as a solid model which reproduced the cavity to the interior manufactured by the above-mentioned all directions method invention.

[0121] Moreover, invention of claim 12 or claim 13 has the advantage of excelling in the recognition nature of the cavity reproduced inside as a solid model which reproduced the cavity to the interior manufactured by the above-mentioned all directions method invention.
[0122] Moreover, invention of claim 14 has the advantage of having flexibility, as a solid model which reproduced the cavity to the interior manufactured by the above-mentioned all directions method invention.

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] Especially in the solid model of internal organs or organs as which the manufacture approach is proposed by JP,5-11689,A, the reproducing-to precision-configuration of whole target part chief aim is not placed, and emphasis is not necessarily put on reproducing the cavity which exists in the body. However, in various fields, such as operation trial which actually uses medical equipment besides grasp of the configuration of a cavity, or structure, various use is possible for the solid model reproducing the cavity which exists in the body, and it is very useful to manufacture such a solid model.
[0010] the molding ingredient for which it depended on the property of the laminating molding system used for laminating molding at manufacture of this solid model like JP,5-11689,A on the other hand when a solid model was manufactured by laminating molding -- not using it -- it does not obtain but the degree of freedom of ingredient selection is very low. And in the present condition, it is difficult or impossible for the molding ingredient equipped with high transparency, for example, the molding ingredient equipped with sufficient flexibility to reproduce body tissue, etc. to hardly exist, but to manufacture a solid model with those properties therefore. Moreover, by laminating molding which molds a solid model, the duration over molding increases by leaps and bounds with the increment in the molding volume of a solid model, improvement in molding precision, etc. by carrying out the laminating of the very thin molding layer. Therefore, by the approach proposed by JP,5-11689,A, in molding a solid model with the big molding volume directly by laminating molding, it is obliged to spend long duration on molding of a solid model.
[0011] For this reason, the solid model and list which reproduced the cavity which was constituted with ingredients other than the molding ingredient depending on the property of the laminating molding system used for laminating molding, and which exists in the body inside are expected to obtain the manufacturing technology for manufacturing, without increasing the duration over molding by leaps and bounds with this solid model to the increment in the molding volume, improvement in molding precision, etc.

[0012]
[Objects of the Invention] This invention is made in view of the above-mentioned technical problem. The purpose The solid model which was constituted with ingredients other than the molding ingredient depending on the property of the laminating molding system used for laminating molding and which reproduced the cavity which exists in the body inside, It is in obtaining the manufacturing technology for manufacturing, without increasing the duration over molding by leaps and bounds with this solid model to the increment in the molding volume, improvement in molding precision, etc.
[0013]
[A terminological definition] Each vocabulary in this specification is defined as follows.
[0014] A "cavity" is vocabulary which names generically the dead air space which exists in the body, and points out the dead air space constituted by geometry, such as these many organs, body walls, etc., to the dead air space which exists in many organs (a frame, a muscle, a circulatory organ, a breather, a digestive organ, a urination reproductive organ, an endocrine organ, a nerve, sensor, etc.), and a list. Therefore, the lumen of many organs, such as the lumen of the heart, a stomach lumen, an intestinal lumen, a lumen of a uterus, a lumen of a blood vessel, and a lumen of a ureter, the oral cavity, a nasal cavity, fauces, a middle ear cavity, a coelome, the cavum articulare, a pericardium, etc. are contained in a "cavity."
[0015] pass laminating molding with a "laminating molding model" -- the vocabulary which points out the

produced three-dimensions molding object -- it is -- therefore -- laminating molding -- pass a series of molding strokes including laminating molding, without being limited to the three-dimensions molding object therefore produced independently -- the produced three-dimensions molding object is also included.

[0016] A "solid model" is vocabulary which points out only the model reproducing a cavity to the interior obtained by this invention, and it is distinguished from the "three dimensional object model" used when pointing out the model of other general solid configurations in this specification. Therefore, although the model obtained by laminating molding is contained in a "three dimensional object model", it is not contained in a "solid model."

[0017] "Photography equipment" is vocabulary which names generically the equipment which can acquire the data about the cavity which exists in the body by taking a photograph, and the X-ray plant (an X-ray CT scanner is included) of various methods, MRI equipment, an ultrasonic device, etc. are contained in "photography equipment."

[0018] A "molding material" is vocabulary which hardens and names an usable ingredient generically to shaping of a three-dimensions molding object using this property.

MEANS

[Means for Solving the Problem]

[0019] In order to attain the above-mentioned purpose, in invention of claim 1 By being eluted, the laminating molding model reproducing the cavity which exists in the body It is the approach of obtaining the solid model which formed the cavity which has the same configuration as this laminating molding model, and reproduced said cavity inside by this, and is (a). The preparation stroke which prepares the data for carrying out laminating molding of the laminating molding model reproducing a cavity, (b) The laminating molding stroke which produces said laminating molding model through laminating molding using said data, (c) The formation stroke which is made to harden this molding material and forms a solid model after filling with a molding material the perimeter of said laminating molding model obtained in the laminating molding stroke, (d) Said laminating molding model is fused with heating, and it is characterized by having the elution stroke eluted to the exterior of the solid model pass hardening of said molding material in the formation stroke.

[0020] Invention of claim 2 the laminating molding model reproducing the cavity which exists in the body moreover, by being eluted It is the approach of obtaining the solid model which formed the cavity which has the same configuration as this laminating molding model, and reproduced said cavity inside by this, and is (a). The preparation stroke which prepares the data for carrying out laminating molding of the laminating molding model reproducing a cavity, (b) The laminating molding stroke which produces said laminating molding model through laminating molding using said data, (c) The formation stroke which is made to harden this molding material and forms a solid model after filling with a molding material the perimeter of said laminating molding model obtained in the laminating molding stroke, (d) Said laminating molding model is dissolved with a solvent, and it is characterized by having the elution stroke eluted to the exterior of the solid model pass hardening of said molding material in the formation stroke.

[0021] Invention of claim 3 the laminating molding model reproducing the cavity which exists in the body moreover, by being eluted It is the approach of obtaining the solid model which formed the cavity which has the same configuration as this laminating molding model, and reproduced said cavity inside by this, and is (a). The preparation stroke which prepares the data for carrying out laminating molding of the laminating molding model reproducing a cavity, (b) The laminating molding stroke which produces said laminating molding model through laminating molding using said data, (c) The formation stroke which is made to harden this molding material and forms a solid model after filling with a molding material the perimeter of said laminating molding model obtained in the laminating molding stroke, and (d) By using together melting by heating, and the dissolution by the solvent It is characterized by having the elution stroke eluted

in said laminating molding model to the exterior of the solid model pass hardening of said molding material in the formation stroke.

[0022] Invention of claim 4 is characterized by having the data generation stroke which generates said data further prepared for the interior of a publication at said preparation process in the manufacture approach of the solid model reproducing a cavity at either of claim 1 to claims 3 based on photography by photography equipment before said preparation process.

[0023] In the manufacture approach of a solid model that invention of claim 5 reproduced the cavity inside the publication to either of claim 1 to claims 4 further the line after said elution stroke It is characterized by having the diffusion removal stroke which the component of said laminating molding model diffused inside said solid model in said elution stroke as a stroke which intervenes in the middle of said elution stroke is evaporated by heating said solid model, and removes it from the interior of said solid model.

[0024] Invention of claim 6 is characterized by to produce said laminating molding model through laminating molding of a method which carries out a laminating at the same time it forms a sintering hardening layer and carries out sequential formation of this sintering hardening layer by scanning laser at a powder-like ingredient [molding] top in the manufacture approach of the solid model which reproduced the cavity inside the publication to either of claim 1 to claims 5.

[0025] It carries out that invention of claim 7 produces said laminating molding model through laminating molding of a method which carries out a laminating at the same time it makes a nozzle head scan, it forms a thin layer and it carries out sequential formation of this thin layer, make the molding ingredient which carried out heating fusion from the nozzle spouted or dropped, and solidify it in the manufacture approach of the solid model which reproduced the cavity inside the publication to either of claim 1 to claims 5 as the description.

[0026] In the manufacture approach of a solid model that invention of claim 8 reproduced the cavity inside the publication to either of claim 1 to claims 5 Making it extrude and solidify from a nozzle so that a molding ingredient may be extruded and the molding ingredient of the shape of this thin line may be drawn from a nozzle It is characterized by producing said laminating molding model through laminating molding of a method which carries out a laminating at the same time it forms a thin layer and carries out sequential formation of this thin layer by making a nozzle head scan.

[0027] Invention of claim 9 to claim 14 has the advantage of the solid model which reproduced the cavity to the interior manufactured by such manufacture approach.

[0028] Among these, the solid model which reproduced the cavity inside invention of claim 9 is (a). The solid model formation part formed of hardening of a molding material, and (b) It is characterized by having the cavernous part formed by eluting a laminating molding model through melting by heating.

[0029] Moreover, the solid model which reproduced the cavity inside invention of claim 10 is (a). The solid model formation part formed of hardening of a molding material, and (b) It is characterized by having the cavernous part formed by eluting a laminating molding model through the dissolution by the solvent.

[0030] Moreover, the solid model which reproduced the cavity inside invention of claim 11 is (a). The solid model formation part formed of hardening of a molding material, and (b) It is characterized by using together melting by heating, and the dissolution by the solvent, and having the cavernous part formed by eluting a laminating molding model.

[0031] The solid model which reproduced the cavity inside invention of claim 12 is a solid model which reproduced the cavity inside the publication to either of claim 9 to claims 11, and is characterized by having transparency, after said molding material's hardening.

[0032] The solid model which reproduced the cavity inside invention of claim 13 is a solid model which reproduced the cavity to the interior according to claim 12, and is characterized by having at least one flat surface in the external configuration of said solid model.

[0033] The solid model which reproduced the cavity inside invention of claim 14 is a solid model which reproduced the cavity inside the publication to either of claim 9 to claims 13, and is characterized by using silicone rubber (a silicone elastomer or silicone gel) for said all or a part of solid model formation part.

[0034]

[Embodiment of the Invention] Hereafter, this invention is explained to a detail based on an accompanying drawing.

[0035] A whole [that drawing 1 showed 1 of the operation of the laminating / having reproduced a cavity / that laminating molding produces a whole / having shown 1 of the operation of a solid / having reproduced a cavity inside / model gestalt / perspective view and drawing 2 / molding model of this invention gestalt] perspective view and drawing 3 are important section [showing the cross-section structure at the time of having produced a laminating / having reproduced a cavity / show in drawing 2 / molding model as the structure of hollow] cross-section expansion perspective views. Drawing 4 to drawing 8 is the flow chart which explained the outline as one step about the manufacture approach of the solid model which reproduced the cavity inside this invention as, respectively as each manufacture line, and the flow chart of drawing 8 supports the manufacture approach of the solid model which reproduced the cavity from claim 1 to the interior according to claim 5 from drawing 4 , respectively. In addition, the same step number is used for the stroke which is mutually common in each of these drawings.

[0036] Below, the manufacture approach of the solid model which reproduced the cavity inside this invention is explained to a detail based on an accompanying drawing.

[0037] The solid model which reproduced the cavity inside this invention (a) The preparation stroke which prepares the data for carrying out laminating molding of the laminating molding model reproducing a cavity, (b) The laminating molding stroke which produces said laminating molding model through laminating molding using said data, (c) The formation stroke which is made to harden this molding material and forms a solid model after filling with a molding material the perimeter of said laminating molding model obtained in the laminating molding stroke, (d) It is manufactured by the manufacture approach characterized by having the elution stroke eluted in said laminating molding model to the exterior of the solid model pass hardening of said molding material in the formation stroke. Furthermore, by the manufacture approach according to claim 4, it has the data generation process which generates said data prepared at said preparation process based on photography by photography equipment before said preparation process. Moreover, as a stroke which intervenes in the middle of the stroke after said elution stroke, or said elution stroke, by heating said solid model, the component of the component of said laminating molding model diffused inside said solid model in said elution stroke is evaporated, and it has the diffusion removal stroke removed from the interior of said solid model by the manufacture approach according to claim 5.

[0038] Below, each production process concerning manufacture of the solid model which reproduced the cavity inside this invention is explained to a detail, making it contrast with each step shown in the flow chart of drawing 8 from drawing 4 .

[0039] <A. data generation stroke> The manufacture approach of the solid model which reproduced the cavity to the interior according to claim 4 is characterized by having the data generation process which generates the data (data for carrying out laminating molding of the laminating molding model reproducing a cavity) prepared at a preparation process based on photography by photography equipment. Below, the operation gestalt of this data generation process is explained in full detail. This data generation process corresponds to the step ST 0 of the flow chart shown in drawing 7 and drawing 8 .

[0040] In order to generate the data prepared at a preparation process based on photography by photography equipment, the 2-dimensional image of the target body or a three dimensional image is first obtained with photography equipments, such as an X-ray CT scanner and MRI equipment. What can obtain only a 2-dimensional image, and the thing which can obtain a three dimensional image exist in photography equipment according to a class. Since the image information of the three dimensions about said cavity is needed for generation of said data, to use the photography equipment with which only a 2-dimensional image is obtained, it is necessary to obtain two or more 2-dimensional images by taking a photograph by changing a camera station. In addition, what is necessary is just to make a change of a camera station by the parallel displacement. The image information of the three dimensions needed for generation of said data is obtained by being able to photo two or more 2-dimensional images at regular intervals or arbitration spacing,

and carrying out the laminating of the obtained 2-dimensional image based on photography spacing by this. However, what is necessary is just to make a change of a camera station freely, without being based on a parallel displacement, as long as the image information of sufficient three dimensions is obtained (migration of a camera station in the direction of arbitration, or rotation of bearing of the exposure axis). Moreover, you may use combining the 2-dimensional image and three dimensional image which were obtained by two or more photography equipments. In addition, in order to link with the precision of reappearance of a cavity configuration directly, it is necessary to adjust appropriately photography spacing (photography consistency) of a 2-dimensional image according to the precision of reappearance needed.

[0041] Next, available typical photography equipment is explained to photography of these 2-dimensional images and a three dimensional image. However, there are various things besides the equipment explained below in photography equipment, and this invention is not limited to these photography equipments.

[0042] As an X-ray CT scanner, perform photography by the X-ray from all the directions of [on the horizontal same cross section of the body], and by computer-processing the acquired information Moving the target body besides [which obtains the 2-dimensional image of a photography cross section] the X-ray CT scanner of the conventional method in the direction of a body axis On the other hand, by performing spiral roentgenography and computer-processing the three-dimensions information on the body obtained by this by taking a photograph, rotating an X-ray detection device in a flat surface perpendicular to a body axis There is an X-ray CT scanner of the helical scan which can obtain a three dimensional image and the 2-dimensional image in an arbitration cross section etc. Furthermore, by building the X-ray detection device of many trains in the interior of equipment, two or more coincidence photography is enabled and the thing of a multi-slice method which realized improvement in spatial resolving power, compaction of exposure time, etc. by this also exists in the X-ray CT scanner of a helical scan.

[0043] MRI equipment is equipment using the nuclear-magnetic-resonance phenomenon of the hydrogen atom which constitutes the great portion of body, and this phenomenon images the condition of an organization based on being influenced by the difference in the environment the amount of a hydrogen atom, and around a hydrogen atom included in body tissue. According to this equipment, it is possible to obtain the 2-dimensional image of an arbitration cross section, without changing the location of the target body, and it is also possible to obtain the 2-dimensional image of many cross sections to coincidence further. This MRI equipment has an advantage in respect of the ability to carry out the photography photography of that soft tissue can be photoed by high contrast, the blood vessel surrounded by the osseous tissue since it was not influenced of the osseous tissue vividly compared with an X-ray CT scanner.

[0044] Next, the data (following and three-dimensions configuration data) about the three-dimensions configuration of the cavity made into the object of solid modeling are generated based on these 2-dimensional images and three dimensional images that were obtained by photography equipment. Although carried out by using the software which makes this possible, a series of processings concerning generation of this three-dimensions configuration data may use two or more software in that process, when single software cannot perform all processings. In addition, in current, two or more marketing is carried out and the software which performs processing of these single strings automatically may use those software.

[0045] based on the 2-dimensional image (two or more sheets need) or three dimensional image obtained by photography equipment, various approaches as a well-known technique have already exist in the approach of generate the three dimensions configuration data of the specific part in a photography field, and although one gestalt of those approaches be mention and explain in full detail here since it be difficult to explain all approaches in full detail, this invention be limit to the operation gestalt describe below.

[0046] Although the case where two or more 2-dimensional images obtained by taking a photograph at equal intervals are used as an input image is explained, even when using as an input image here the 2-dimensional image obtained by other photography approaches, or a three dimensional image, carrying out a parallel displacement in the direction of a body axis, the three-dimensions configuration data of a cavity can be obtained by performing same processing. Based on photography spacing at the time of photography, the laminating of the inputted 2-dimensional each image is carried out correctly first. Next, by specifying the

threshold about an image concentration value on a 2-dimensional each image, only the cavity field made into the object of solid modeling is extracted from the inside of a 2-dimensional each image, and other fields are deleted by one side from the inside of the 2-dimensional image by which the laminating was carried out. It is given in the form where the three-dimensions configuration of the part which is equivalent to said cavity field by this carried out the laminating of the 2-dimensional image, and the border line of this 2-dimensional each image is interpolated in three dimensions, and the three-dimensions configuration data of the target cavity are generated by reconfigurating as a three-dimensions curved surface. In addition, although the cavity field was first extracted from the inside of an input image by specifying the threshold about a concentration value in this case, it is also possible by a cavity front face's extracting and carrying out three-dimensions interpolation from the inside of an input image, to generate a three-dimensions curved surface directly by specifying the specific concentration value which gives a cavity front face apart from this approach. Moreover, after performing the field extract (or surface extract by specific concentration value assignment) by threshold assignment, the laminating of an input image may be performed. Moreover, polygon approximation may perform generation of a three-dimensions curved surface.

[0047] In addition, to said three-dimensions configuration data, it is possible to perform correction and modification of a configuration during generation of these three-dimensions data or after generation. adding the structure not existing into the image data obtained by photography, or for example, adding the supporting structure called a support -- or it is possible to remove a part of structure in said image data, to change the configuration of a cavity, etc., and the configuration of the cavity formed in the interior of the solid model 11 of this can be corrected or changed freely. Furthermore, it is also possible to establish a non-laminating molding field in the interior of a cavity, and the interior explained later is made into structure in the air, and in producing the laminating molding model which formed the non-laminating molding field 31, it generates the three-dimensions data which established such a non-laminating molding field 31 in the interior of a cavity. In addition, these processings may be performed in the software corresponding to a laminating molding system or a laminating molding system.

[0048] Next, the three-dimensions configuration data of the generated cavity are sent to the software corresponding to the laminating molding system used changing into the format corresponding to the laminating molding system used for laminating molding of the laminating molding model 21 if needed, or the laminating molding system to be used.

[0049] By the laminating molding system (or software corresponding to a laminating molding system), a support adds a support (supporting structure) to a required part for the purpose, such as configuration maintenance under laminating molding, at the same time it sets up various setting items, such as arrangement of the laminating molding model 21 at the time of laminating molding, and the direction of a laminating, (if unnecessary, it is not necessary to add). The slice data directly used for laminating molding are generated by slicing the data for molding obtained by doing in this way by the last based on the molding thickness at the time of laminating molding. In addition, contrary to the above-mentioned procedure, a support may be added, after generating slice data. Moreover, when automatically generated by the laminating molding system (or software corresponding to a laminating molding system) which slice data use, it is not necessary to generate slice data. However, a setup of laminating molding thickness is needed in that case. When the same is said of addition of a support and a support is automatically generated by the laminating molding system (or software corresponding to a laminating molding system), it is not necessary to generate manually (you may generate manually).

[0050] <B. preparation process> A preparation process the data for carrying out laminating molding of the laminating molding model 21 reproducing the cavity made into the object of solid modeling It prepares for direct laminating molding in the same gestalt as the data obtained as the last gestalt of the above-mentioned data generation process as available data (it is hereafter called laminating molding data), and it is the stroke with which laminating molding is equipped, and corresponds to the step ST 1 of the flow chart shown in drawing 8 from drawing 4 R> 4. However, this preparation process is a stroke with which prepares laminating molding data and laminating molding is equipped, and is not a stroke which generates

laminating molding data (no process about generation of laminating molding data is included in this preparation process).

[0051] <C. laminating molding stroke> A laminating molding stroke is a stroke produced by laminating molding using said laminating molding data prepared in said preparation process in said laminating molding model 21 reproducing the configuration of the cavity made into the object of solid modeling, and corresponds to the step ST 2 of the flow chart shown in drawing 8 from drawing 4 . Below, the operation gestalt of this laminating molding stroke is explained in full detail.

[0052] The laminating molding model 21 reproducing the cavity produced by laminating molding is used as a disappearance model for ROSUTO waxes in a next process. The disappearance model for ROSUTO waxes is the model originally used by the precision casting called ROSUTO wax casting, and after coating and calcinating the perimeter of this model with refractories and ceramic refractories of a particle, it is used by melting and removing this model in order to manufacture the mold for casting the casting which has the same configuration as said disappearance model. However, in this invention, said laminating molding model 21 produced by laminating molding is not used for the purpose of the aforementioned mold manufacture. After forming the solid model 11 by filling the particular part of the whole perimeter or a perimeter, and stiffening this molding material with a molding material, the laminating molding model 21 which exists in the solid model 11 interior -- (a) the heating scorification fused with heating -- or (b) the solvent solution process which dissolves with a solvent -- or (c) By fluidizing alternatively and being eluted to the exterior of the solid model 11 by applying whether it is the hybrid method and ******** which use together melting by heating, and the dissolution by the solvent It is used in order to manufacture the solid model 11 which has a cavity with the same configuration thru/or the structure as the target cavity inside. In addition, in heating scorification, a solvent solution process corresponds to claim 2, and a hybrid method corresponds to claim 1 at claim 3, respectively.

[0053] Therefore, in this invention, the following constraints which have relation mutually are imposed depending on any shall be used between the aforementioned heating scorification, a solvent solution process, and a hybrid method between the ingredient (it is hereafter called a molding ingredient) used for laminating molding of the laminating molding model 21, and the ingredient (it is hereafter called a molding material) used for shaping of the solid model 11.

[0054] (1) To perform elution of the laminating molding model 21 with said heating scorification, it is necessary to fulfill the constraint of both the following (1-1) and (1-2).

(1-1) Fuse said molding ingredient with heating.

(1-2) Said molding material can be hardened in temperature lower than the melting temperature of a molding ingredient given in a constraint (1-1), and has heat-resistant temperature higher than the melting temperature of the molding ingredient of a publication in a constraint (1-1) after hardening.

[0055] (2) To perform elution of the laminating molding model 21 with said solvent solution process, it is necessary to fulfill the constraint of both the following (2-1) and (2-2).

(2-1) Said molding ingredient dissolves in a solvent (such a solvent exists).
 (2-2) Said molding material has solvent resistance among the solvents of a publication to at least one kind of solvent (it is hereafter called a specific solvent) in a constraint (2-1).

[0056] (3) To perform elution of the laminating molding model 21 with said hybrid method, it is necessary to fulfill the constraint of both the following (3-1) and (3-2).

(3-1) Fuse said molding ingredient with heating, and it dissolves in a solvent (such a solvent exists).

(3-2) While said molding material can be hardened in temperature lower than the melting temperature of a molding ingredient given in a constraint (3-1) and it has heat-resistant temperature higher than the melting temperature of the molding ingredient of a publication in a constraint (3-1) after hardening, it has solvent resistance to at least one kind of solvent (specific solvent) among the solvents of a publication in a constraint (3-1).

[0057] In addition, in case it fills the perimeter of this laminating molding model with said molding material in the following formation stroke, as long as it is range which has the reinforcement which can bear external

force, such as a pressure added from the outside, said laminating molding model 21 makes the interior hollow structure, by establishing the non-laminating molding field 31 in the interior, may carry out the thinning of the appearance side, and may produce it. The cost accompanying the time amount and molding by which necessary is carried out to laminating molding is not only reduced by this, but by it, the easy elution of the laminating molding model 21 becomes possible in a next elution stroke. However, the interior is made into structure in the air, and in order to mold the laminating molding model which equipped the interior with the non-laminating molding field 31, the laminating molding data prepared in a previous preparation stroke need to be generated so that this molding may be performed.

[0058] Laminating molding of for example, a powder sintering method, laminating molding of a melting resin jet method, laminating molding of a melting resin extrusion method, etc. are mentioned to laminating molding which enables use of the molding ingredient with which are satisfied of the constraint concerning the above-mentioned heating scorification, a solvent solution process, or a hybrid method. Below, these various laminating molding methods are explained in full detail. However, laminating molding concerning the manufacture approach of this invention is not limited to these methods.

[0059] In laminating molding of a powder sintering method, by scanning beams for heating, such as laser, on the powder ingredient laid by the plane based on said laminating molding data, melting of the powdered front face is carried out, powder is joined, and the sintered powder thin layer is formed. Junction to the lower layer thin film already sintered at this time is also performed to coincidence. Next, laminating molding of the laminating molding model 21 is performed by performing laminating molding of a method which carries out a laminating at the same time the thin layer of new powder is again supplied to a top face, repeats this stroke and carries out sequential formation of the powder sintering layer.

[0060] In laminating molding of a melting resin multiaxial type, making a nozzle head scan on a flat surface based on said laminating molding data, laminating molding of the laminating molding model 21 is performed by performing laminating molding of a method which carries out a laminating at the same time make the molding ingredient fused from the nozzle spouted or dropped, it carries out deposition solidification, it forms a thin layer and it carries out sequential formation of this thin layer.

[0061] In laminating molding of a melting resin extrusion mold, a molding ingredient is extruded from a thin nozzle, a thin layer is formed by making a nozzle head scan on a field based on said laminating molding data, making it send out and solidify from a nozzle so that the ingredient of the shape of this thin line may be drawn, and laminating molding of the laminating molding model 21 is performed by performing laminating molding of the method which carries out the laminating of this.

[0062] In addition, it is possible to add various kinds of processings (removal processing and addition processing), such as surface polish and addition of surface coating, to the laminating molding model 21 produced by laminating molding after laminating molding, and it is possible to correct or change the configuration of the laminating molding model 21 by this. The support is removed when the removal after laminating molding adds a required support in production of the laminating molding model 21 as part of these processings.

[0063] <D. formation stroke> After a formation stroke fills with a molding material the perimeter of said laminating molding model 21 obtained in the laminating molding stroke, it is a stroke which is made to harden this molding material and forms the solid model 11, and corresponds to the step ST 3 of the flow chart shown in drawing 8 from drawing 4 . Below, the operation gestalt of this formation stroke is explained in full detail.

[0064] Formation of the solid model 11 around the laminating molding model 21 produced in said laminating molding stroke (1) The molding material with which it is satisfied of said constraint (1-2) when using heating scorification in a next elution stroke, (2) The molding material with which it is satisfied of said constraint (2-2) when using a solvent solution process in a next elution stroke, and (3) or [filling with the molding material with which it is satisfied of said constraint (3-2) in using a hybrid method] -- or after covering, it carries out by stiffening this molding material. in addition -- if the dies body of the request configuration prepared beforehand is used in case the perimeter of the laminating molding model 21 is filled

with a molding material -- being good (the interior of this dies body being filled with said laminating molding model 21 and molding material) -- do not use a dies body, but the molding material of the shape of a sol or powder is made to adhere to the front face of the laminating molding model 21, and the solid model 11 may be formed by stiffening this (dipping shaping, slush molding). When using a dies body, it is desirable to prepare for removal of a next dies body and to use an ingredient with a low affinity with said molding material to be used. However, it is good also as some solid models 11 which do not remove a dies body but are finally obtained.

[0065] In addition, when fabricating the external configuration of the solid model 11 by the dies body, it is possible to reproduce both external configurations, such as many organs which carry out entailment of a cavity and this cavity, by making the cavity for the configuration of the shaping side of a dies body in agreement with external configurations, such as many organs which carry out entailment.

[0066] However, the external configuration of the solid model 11 does not need to make the target cavity in agreement with external configurations, such as many organs which carry out entailment, and may be replaced in other configurations (for example, cube configuration etc.). For example, when manufacturing the solid model 11 using the molding material which has transparency, the recognition nature of the cavity reproduced inside this solid model can be raised by establishing a flat surface 14 in the external configuration of this solid model.

[0067] Moreover, to the external configuration of the solid model 11, various kinds of removal processing and addition processings may be performed after formation by hardening of a molding material, it can graduate by this or correction and modification can be added to a configuration.

[0068] <E. elution process> Next, the operation gestalt of the eluted elution stroke which is eluted in the laminating molding model 21 to the exterior of said solid model obtained in the formation stroke with said heating scorification, said solvent solution process, or said hybrid method is explained in full detail. It has the elution stroke characterized by eluting claim 1, claim 2, and claim 3 in a laminating molding model using said heating scorification, said solvent solution process, and said hybrid method, respectively. The elution stroke which distinguished these from drawing 4 with the flow chart shown in drawing 8 , and used said heating scorification corresponding to claim 1 Step ST4a, It wrote step ST4c [the elution stroke using said hybrid method corresponding to step ST4b and claim 3 for the elution stroke using said solvent solution process corresponding to claim 2].

[0069] After forming the solid model 11 by stiffening a molding material, while removing said dies body, the laminating molding model 21 is eluted and removed to the exterior of the solid model 11 with said heating scorification, said solvent solution process, or said hybrid method. What is necessary is not to limit this invention to this sequence and just to carry out removal of a garbage in order of arbitration, although described on explanation below in order of removal of a dies body, and elution ** of the laminating molding model 21. That is, it is in the middle of removing a dies body after removal of the laminating molding model 21, and removal of the laminating molding model 21, and it is possible to remove a dies body (the laminating molding model 21 or in the middle of removal of a dies body removal), to remove the laminating molding model 21 and a dies body by turns gradually, etc.

[0070] Removal of a dies body is performed by the predetermined removal approach. However, removal is unnecessary when using a dies body as some solid models 11.

[0071] Removal of the laminating molding model 21 from the solid model 11 interior is performed with the aforementioned heating scorification, a solvent solution process, or a hybrid method. Below, each approach is explained. In addition, although elution of the laminating molding model 21 is performed from the elution part 15 which the laminating molding model 21 exposed from the solid model 11, when such an elution part 15 does not exist, it performs removal processing to a case in part to the front face of the solid model 11, and forms the elution part 15 of the laminating molding model 21 in it. In addition, this removal processing may be performed before melting of the laminating molding model 21, or the dissolution, and melting or after dissolving, it may perform the laminating molding model 21.

[0072] By fusing alternatively the laminating molding model 21 which exists in the solid model 11 interior,

and fluidizing it with heating, heating scorification is an approach of removing by carrying out elution, and the application is more possible for it than the solid model 11 interior only within the case where both said constraint (1-1) and (1-2) are satisfied.

[0073] The laminating molding model 21 of the solid model 11 interior is fused alternatively, and is made to fluidize in this heating scorification by heating first to temperature higher [than the melting temperature of the molding ingredient of the laminating molding model 21] and lower than the heat-resistant temperature of the molding material of the solid model 11 after hardening. If the laminating molding model 21 responds in order of the solid model 11 and dies body removal before elution, it is in the condition of having been united with the dies body, but when both said constraint (1-1) and (1-2) are satisfied, it is possible by heating such whole structure or a part with a heater etc. to fuse the laminating molding model 21 alternatively. In addition, it is also possible to also perform heating of the solid model 11 from the solid model exterior and to heat from the interior of a solid model by irradiating the exterior to to arrange a heating electrode inside a solid model and a laminating molding model, laser, etc., although it is possible etc. Next, it removes by carrying out elution of the laminating molding model 21 to the exterior of the solid model 11 in this condition. Although the inertia generated by giving remote force, such as gravity and a centrifugal force, an impact, and vibration can be used at the time of the elution of this laminating molding model 21, it is also possible to promote elution by applying external pressure (positive pressure, negative pressure) to the part which the laminating molding model 21 exposed, or slushing other liquids into the interior of a cavity. Moreover, the laminating molding model 21 (some laminating molding models 21 which remained to the solid model 11 interior especially after elution) of the solid model 11 interior may be eliminated to the exterior of the solid model 11 in the condition of solid phase by applying direct external force, giving an impact and vibration, or grasping directly etc. Under the present circumstances, the laminating molding model 21 of the solid model 11 interior may be disassembled into two or more parts.

[0074] Into the molding ingredient of the laminating molding model 21 which enables application of this heating solution process Various kinds of thermoplastics (thermoplastic) (what has a high (the viscosity at the time of melting is low) fluidity at the time of melting is desirable) and waxes (fats and oils, paraffin, etc.), Or various ingredients can be used as long as it fuses in temperature lower than the heat-resistant temperature of the molding material used for formation of the solid model 11 besides being a low-melt point point metal, ice(water), etc. In addition, it is necessary to opt for selection of these molding ingredients according to the property of the molding material used for the solid model 11 (a molding material may be chosen according to the property of a molding ingredient).

[0075] By dissolving alternatively and fluidizing with a solvent, the laminating molding model 21 which exists in the solid model 11 interior, a solvent solution process is an approach of removing by carrying out elution, and the application is more possible for it than the solid model 11 interior only within the case where both said constraint (2-1) and (2-2) are satisfied.

[0076] It dissolves alternatively and the laminating molding model 21 of the solid model 11 interior is made to fluidize in this solvent solution process by using the specific solvent first given according to said constraint (2-2). Although it is in the condition of having been united with the dies body if the laminating molding model 21 responds in order of the solid model 11 and dies body removal before elution When both said constraint (2-1) and (2-2) are satisfied, it is possible to dissolve the laminating molding model 21 alternatively by contacting the part containing the part which such whole structure or the laminating molding model 21 exposed to said specific solvent. Next, it removes by carrying out elution of the laminating molding model 21 to the exterior of the solid model 11 in this condition. It is also possible to promote elution by being able to use the inertia generated by giving remote force, such as gravity and a centrifugal force, an impact, and vibration as well as the case of heating scorification, applying external pressure (positive pressure, negative pressure) to the part which the laminating molding model 21 exposed, or slushing other liquids into the interior of a cavity etc. at the time of the elution of this laminating molding model 21. Moreover, the laminating molding model 21 (some laminating molding models 21 which remained to the solid model 11 interior especially after elution) of the solid model 11 interior may be eliminated to the

exterior of the solid model 11 in the condition of solid phase by applying direct external force, giving an impact and vibration, or grasping directly etc. Under the present circumstances, the laminating molding model 21 of the solid model 11 interior may be disassembled into two or more parts.

[0077] Into the molding ingredient of the laminating molding model 21 which enables application of this solvent solution process, use of the various resin which has soluble agent solubility, such as adhesion matter, such as cyanoacrylate (it dissolves in an acetone) and starch (it dissolves in water etc.), and toluenesulfonamide resin (it dissolves in an acetone etc.), polyvinyl alcohol (it dissolves in water etc.), waxes (fats and oils, paraffin, etc.), etc. is possible. In addition, when enforcing a solvent solution process, selection of the molding ingredient which the molding material used for the solid model 11 needs to have solvent resistance to the solvent used for the dissolution of the laminating molding model 21, and uses for the laminating molding model 21 is good to determine according to the property of the molding material used for the solid model 11 (a molding material may be chosen according to the property of a molding ingredient).

[0078] By using together the heating scorification and the solvent solution process which were explained in full detail previously, a hybrid method is an approach of removing by carrying out elution of the laminating molding model 21 which exists in the solid model 11 interior from the solid model 11 interior, and the application is possible for it only within the case where both said constraint (3-1) and (3-2) are satisfied.

[0079] this hybrid method -- (1) The stroke eluted in the laminating molding model 21 from the solid model 11 interior with heating, and (2) a solvent -- by carrying out the stroke eluted in the laminating molding model 21 from the solid model 11 interior in order of arbitration, said laminating molding model 21 is removed from the solid model 11 interior (or thing done for the multiple-times operation of each process in the sequence of arbitration). Below, each of these processes are explained in full detail.

[0080] (1) Fuse alternatively the laminating molding model 21 of the solid model 11 interior, and make it fluidize by heating the laminating molding model 21 from the solid model 11 interior first in the eluted stroke with heating to temperature higher [than the melting temperature of the molding ingredient of the laminating molding model 21] and lower than the heat-resistant temperature of the molding material of the solid model 11 after hardening. If the laminating molding model 21 responds in order of the solid model 11 and dies body removal before elution, it is in the condition of having been united with the dies body, but when both said constraint (3-1) and (3-2) are satisfied, it is possible by heating such whole structure or a part with a heater etc. to fuse the laminating molding model 21 alternatively. In addition, it is also possible to also perform heating of the solid model 11 from the solid model exterior and to heat from the interior of a solid model by irradiating the exterior to to arrange a heating electrode inside a solid model and a laminating molding model, laser, etc., although it is possible etc. Next, it removes by carrying out elution of the laminating molding model 21 to the exterior of the solid model 11 in this condition. Although the inertia generated by giving remote force, such as gravity and a centrifugal force, an impact, and vibration can be used at the time of the elution of this laminating molding model 21, it is also possible to promote elution by applying external pressure (positive pressure, negative pressure) to the part which the laminating molding model 21 exposed, or slushing other liquids into the interior of a cavity etc. Moreover, the laminating molding model 21 (some laminating molding models 21 which remained to the solid model 11 interior especially after elution) of the solid model 11 interior may be eliminated to the exterior of the solid model 11 in the condition of solid phase by applying direct external force, giving an impact and vibration, or grasping directly etc. Under the present circumstances, the laminating molding model 21 of the solid model 11 interior may be disassembled into two or more parts.

[0081] (2) Dissolve alternatively and make the laminating molding model 21 of the solid model 11 interior fluidize by using the specific solvent first given according to said constraint (3-2) in the stroke eluted in the laminating molding model 21 from the solid model 11 interior with a solvent. Although it is in the condition of having been united with the dies body if the laminating molding model 21 responds in order of the solid model 11 and dies body removal before elution When both said constraint (3-1) and (3-2) are satisfied, it is possible to dissolve the laminating molding model 21 alternatively by contacting the part containing the part which such whole structure or the laminating molding model 21 exposed to said specific solvent. Next, it

removes by carrying out elution of the laminating molding model 21 to the exterior of the solid model 11 in this condition. It is also possible to promote elution by being able to use the inertia generated by giving remote force, such as gravity and a centrifugal force, an impact, and vibration as well as the point, applying external pressure (positive pressure, negative pressure) to the part which the laminating molding model 21 exposed, or slushing other liquids into the interior of a cavity etc. at the time of the elution of this laminating molding model 21. Moreover, the laminating molding model 21 (some laminating molding models 21 which remained to the solid model 11 interior especially after elution) of the solid model 11 interior may be eliminated to the exterior of the solid model 11 in the condition of solid phase by applying direct external force, giving an impact and vibration, or grasping directly etc. Under the present circumstances, the laminating molding model 21 of the solid model 11 interior may be disassembled into two or more parts.

[0082] It is possible to carry out multiple-times operation of each process for each above-mentioned process in the sequence of arbitration in a hybrid method if needed. For example, after being eluted from the solid model 11 interior in most laminating molding models 21 by making the laminating molding model 21 fuse and fluidize from heating, By pouring in the specific solvent given to the cavernous field of the solid model 11 interior which cooled the solid model 11 to the room temperature, and was formed of previous elution according to said constraint (3-2) Some laminating molding models 21 which remained to the solid model 11 interior with surface tension etc. are fluidized again, and it is possible to be eluted to the exterior of the solid model 11 with the poured-in solvent etc.

[0083] As a molding ingredient of the laminating molding model 21 which enables application of this hybrid method, the ingredient which enables application of the both sides of said heating solution process and said solvent solution process can be used, and thermoplastics (thermoplastic), such as toluenesulfonamide resin, and use of waxes (fats and oils, paraffin, etc.) etc. are possible.

[0084] According to the heating scorification and the hybrid method which perform melting of the laminating molding model 21 with heating It is possible for it not to be based on the exposure product of the laminating molding model 21, but to fuse and fluidize the whole laminating molding model in non-contact with advance of the thermal diffusion to the solid model 11 interior. When dissolving the laminating molding model 21 gradually from a surface of action by physical contact like a solvent solution process, it is possible to reproduce easily the cavity of a complicated configuration which is difficult elution, for example, the shape of a high capillary which is an aspect ratio, etc.

[0085] giving direct external force to the laminating molding model 21 from an exposed part besides these approaches, although the approach eluted from the interior of the solid model 11 in the laminating molding model 21 with heating scorification, a solvent solution process, and a hybrid method was explained above, giving impulse force, vibration, etc. from the exterior of the solid model 11, grasping directly, etc. -- etc. -- it is also more possible than the solid model 11 interior to eliminate the laminating molding model 21. Moreover, in this case, the laminating molding model 21 of the solid model 11 interior may be disassembled into two or more parts, and each decomposed part may be taken out from the solid model 11 interior. In addition, when removing the laminating molding model 21 by this approach, it is possible by producing the laminating molding model 21 by making the interior hollow to easy-ize disassembly of the laminating molding model 21. However, application is difficult, when this approach has the complicated configuration of the laminating molding model 21, or when it has the high configuration whose laminating molding model 21 is an aspect ratio.

[0086] The solid model 11 which reproduced the cavity inside divides into plurality the cavity made into the object of solid modeling. By producing the solid model which reproduced each cavity inside by enforcing the manufacture approach of this invention to each divided cavity, and combining the solid model to each obtained cavity It is also possible to obtain the solid model 11 reproducing the whole cavity made into the object of solid modeling. In this case, the solid model to each cavity can also be respectively manufactured by the different manufacture approach. However, this invention also makes the object of invention the solid model to each cavity divided into plurality, and its manufacture approach.

[0087] <F. diffusion removal stroke> The manufacture approach of the solid model which reproduced the

cavity to the interior according to claim 5 As a stroke which intervenes in the middle of the stroke after an elution stroke, or an elution stroke It is characterized by having the diffusion removal stroke which the component of said molding ingredient diffused inside said solid model in the elution stroke is evaporated by heating a solid model again, and removes it from the interior of a solid model. Below, the operation gestalt of this diffusion removal stroke is explained in full detail. In distinction from drawing 8 (a) and drawing 8 (b), the flow chart was shown, respectively by whether this diffusion removal stroke is carried out as a stroke after an elution stroke, or it carries out as a stroke which intervenes in the middle of an elution stroke. In the flow chart of drawing 8 (a), a diffusion removal stroke corresponds to ST5. On the other hand, in the flow chart of drawing 8 (b), the diffusion removal stroke and the elution stroke were shown as one step, and it distinguished as step ST6a, step ST6b, and step ST6c, respectively by using any of said heating scorification, said solution method for solvents, and said hybrid method an elution stroke is carried out.

[0088] The solid model 11 formed of hardening of a molding material in the formation stroke When constituted by the ingredient which has the elasticity of silicone rubber etc. especially, When the laminating molding model 21 is fused with heating in an elution stroke, a part of component (it is hereafter called a diffusion component) of the molding ingredient which constitutes the laminating molding model 21 may be spread inside the solid model 11, and dyeing etc. may be generated in the solid model 11 interior.

[0089] When the laminating molding model 21 is fused with heating, a part of component (it is hereafter called a diffusion component) of the molding ingredient which constitutes the laminating molding ingredient 21 evaporates this diffusion (evaporation), and it originates in being spread to the solid model 11 interior, and is generated. In many cases (except for the case where a diffusion component combines with the component and chemistry target of the solid model 11 etc.), what (it is made to evaporate) is evaporated again is possible for this diffusion component that remained to the solid model 11 interior after the elution of the laminating molding model 21 by heating the solid model 11 again. Since a part of diffusion component evaporated inside the solid model 11 is discharged by diffusion from the solid model 11 interior in the exterior of the solid model 11, it can remove a diffusion component from the solid model 11 interior by this. By cooling, the all deposit to the part, and deposit to a solid model front face depending on the case, and the diffusion component furthermore evaporated inside the solid model 11 removes a diffusion component from the solid model 11 interior by it being also more possible than the solid model 11 interior to remove a diffusion component, and using these approaches in a diffusion removal stroke by this. In addition, when using crosslinked polymer, such as an elastomer, as a molding material, it is possible by using it, choosing the high ingredient of crosslinking density to heighten the effectiveness of the diffusion removal by these approaches.

[0090] Moreover, it is able to remove or discolor dyeing produced by diffusion by this for heating to be able to decompose the diffusion component of the solid model 11 interior, especially coloring matter, etc. in many cases. However, it is necessary to perform heating of the solid model 11 within limits lower than the heat-resistant temperature of the ingredient which constitutes the solid model 11, and in this temperature requirement, this approach can be applied, only when decomposition of a diffusion component is possible.

[0091] As mentioned above, according to the manufacture approach of the solid model of this invention, it is possible to manufacture the solid model which is a short time and reproduced the target cavity inside based on the data for carrying out laminating molding of the laminating molding model 21 of the target cavity. Moreover, the cavity of a complicated configuration can also be reappeared easily. moreover, the solid model which reproduced the affected part etc. for every patient by manufacturing a solid model by the manufacture approach according to claim 4 -- a short time -- and it is supposed that it is possible to manufacture in low invasion or non-invasion in the target body, and it is also possible to use the manufactured solid model for the plan before an operation and the operation trial before an operation.

[0092] <Solid model which reproduced the cavity inside G.> Below, the solid model which reproduced the cavity inside this invention is explained to a detail based on one gestalt of operation shown in an accompanying drawing.

[0093] The solid model which reproduced the cavity inside this invention is (a). The solid model formation

part formed of hardening of a molding material, and (b) It is characterized by having the cavernous part formed by eluting a laminating molding model. The solid model which reproduced the cavity to the interior according to claim 9 carries out the description of being formed, when said cavernous part dissolves a laminating molding model with heating and is eluted. The solid model which reproduced the cavity to the interior according to claim 10 carries out the description of being formed, when said cavernous part dissolves a laminating molding model with a solvent and is eluted. Moreover, the solid model which reproduced the cavity to the interior according to claim 11 is characterized by being formed, when said cavernous part uses together melting by heating, and the dissolution by the solvent and is eluted in a laminating molding model.
[0094] [0095] hereafter explained using a drawing The solid model 11 is equipped with the solid model formation part 12 formed of hardening of a molding material, and the cavernous part 13 formed by eluting the laminating molding model 21.
[0096] [whether among this, the solid model formation part 12 fills the perimeter of the laminating molding model 21 with a molding material, and] After making the molding material of the shape of a sol or powder adhere to the perimeter of the **** laminating molding model 21, it is the part formed by stiffening a molding material. The external configuration When fabricating by making a molding material adhere without a dies body, and hardening in accordance with the configuration of the shaping side of a dies body, in fabricating using a dies body, it is decided with the configuration (volume) change property at the time of hardening of a molding material etc. that they will be the condition of the molding material at the time of molding material adhesion and a list.
[0097] The external configuration of the solid model 11 may be formed as the same configuration as external configurations, such as many organs which may form as configurations of arbitration, such as the shape of the shape of a cylindrical shape, or a globular form, or carry out entailment of the target cavity, without being limited to a cube configuration. Moreover, by making a molding material adhere to the perimeter of the laminating molding model 21, and making it harden, you may form as a configuration of the shape of the shape of a thin film, and thin meat with fixed thickness.
[0098] In order to reproduce the elasticity which a body tissue has as a molding material which can be used for the solid model formation part 12, it is desirable to use the ingredient which has high resiliency, such as an elastomer. However, using the ingredient which has high resiliency may use common molding materials, such as resin, rather than it is indispensable. As a molding material which can be used for the solid model formation part 12, it is independent, or two or more thermosetting resin, such as silicone resin besides elastomers, such as silicone rubber (a silicone elastomer, silicone gel) and a thermosetting polyurethane elastomer, or gel, an epoxy resin, polyurethane, unsaturated polyester, phenol resin, and a urea resin, and thermoplastics, such as a polymethyl methacrylate, can be used, for example, combining them. In addition, molding materials, such as these elastomers, resin, etc. (1) What [is reacted chemically and hardened at a room temperature by adding a catalyst, a curing agent, etc.] (catalyst hardening or polyol hardening) (2) What (moisture hardening) reacts chemically at a room temperature with moisture, and is hardened, and (3) What (oxidation hardening) reacts chemically at a room temperature by oxidation, and is hardened, and (4) By heating Or what (heat hardening) is reacted chemically and hardened by heating after adding a catalyst, a curing agent, etc. and (3) What is hardened by two or more approaches among (1) to (4) can be used.
[0099] After the cavernous part's 13 having filled the perimeter of the laminating molding model 21 with the molding material or making the molding material of the shape of a sol or powder adhere to the perimeter of the **** laminating molding model 21, It is the part formed by eluting the previous laminating molding model 21 from the interior of the solid model formation part 12 formed by stiffening a molding material, and is the part formed when surrounded by the inner surface of the solid model formation part 12.
[0100] Although this cavernous part 13 is a part reproducing the cavity made into the object of solid modeling and is characterized by having the same three-dimensions configuration substantially with the three-dimensions configuration of the cavity made into the object of solid modeling, the three-dimensions configuration of the cavity made into the object of solid modeling and its three-dimensions configuration of this cavernous part 13 do not need to be completely the same. That is, correction and modification may be

added to the configuration, it may originate in the precision of configuration reappearance being low, and both configurations may differ. In addition, the cavity made into the object of solid modeling may be a cavity (or thing which added correction and modification based on it) which exists in the body (a living body or body) which exists, and may be a cavity obtained data and based on knowledge. Moreover, the cavity made into the object of solid modeling may be a cavity which exists in the body of animals other than human being besides the cavity which exists in human being's body.

[0101] In the cavity which exists in human being's body, for example, the lumen of the heart, a stomach lumen, an intestinal lumen, The oral cavity constituted by geometry, such as these many organs besides the lumen of many organs, such as a lumen of a uterus, a lumen of a blood vessel, and a lumen of a ureter, and a body wall, There are a nasal cavity, fauces, a middle ear cavity, a coelome, cavum articulare, a pericardium, etc., and the three-dimensions configuration of the cavernous part 13 can be made into the configuration which reproduced the three-dimensions configuration of these cavities, for example.

[0102] The ingredient which has transparency after hardening may be used for the molding material used for the solid model formation part 12. There are thermosetting resin, such as silicone resin besides elastomers, such as silicone rubber (a silicone elastomer, silicone gel) and a thermosetting polyurethane elastomer, or gel, an epoxy resin, polyurethane, unsaturated polyester, phenol resin, and a urea resin, thermoplastics, such as a polymethyl methacrylate, etc. in the molding material in which the kind which has transparency exists. By forming the solid model formation part 12 using the molding material which has such transparency, the solid model 11 excellent in the recognition nature of the cavernous part 13 reproducing a cavity which exists in the interior can be obtained.

[0103] Moreover, it is possible to establish a flat surface 14 in the external configuration of the solid model formation part 12, i.e., the external configuration of the solid model 11. When fabricating the external configuration of a solid model using a dies body, such a flat surface 14 can be formed by establishing a flat surface on the shaping side of the dies body to be used, and after it forms the solid model formation part 12 by hardening of a molding material, it can also be formed by performing various kinds of removal processing and addition processings. In the flat-surface 14 top established by establishing a flat surface 14 in the external configuration of the solid model 11, since the direction of optical refraction over parallel light can be arranged uniformly, when the solid model formation part 12 is especially formed with the molding material which has transparency, the solid model excellent in the recognition nature of the cavernous part 13 reproducing a cavity which exists in the solid model 11 interior can be obtained. Moreover, by establishing a flat surface 14 in the pars basilaris ossis occipitalis of the solid model 11, when putting a solid model on an even location, stability improves.

[0104] The cavernous part 13 reproducing a cavity has the perimeter surrounded by the inner surface of the solid model formation part 12. It is also possible to insert a medical device etc. and to use for trial of an operation etc., when aiming at such use, it is desirable [the inner surface of the solid model formation part 12] to present the contact property similar to the inner surfaces, such as many organs which carry out entailment of the cavity, therefore as for the solid model 11 of this invention, it is desirable to use the molding material which can reproduce contact properties, such as resiliency which a body tissue has, good for the solid model formation 12. Silicone rubber (a silicone elastomer or silicone gel) is suitable for reproducing the resiliency which is excellent in resiliency and a body tissue has. Moreover, since broad grade exists about resiliency (hardness), it is possible to choose the grade which has the optimal resiliency according to the property of the cavity made into the object of solid modeling. Furthermore, generally silicone rubber (a silicone elastomer or silicone gel) shows non-adhesiveness, is excellent also in surface lubricity by using lubricant, and very suitable for reproducing many physical properties which a body tissue has. Therefore, the solid model which reproduced even contact properties, such as resiliency which not only the configuration of the target cavity but a body tissue has, good can be obtained by forming the solid model formation part 12 using silicone rubber (a silicone elastomer or silicone gel). Moreover, since the kind which has very high transparency also exists in silicone rubber (a silicone elastomer or silicone gel), it is also possible by forming the solid model formation part 12 using silicone rubber (a silicone elastomer or silicone

gel) excellent in such transparency to obtain the solid model excellent in the recognition nature of the cavernous part 13 reproducing a cavity which exists in the solid model 11 interior. Moreover, generally, silicone rubber (a silicone elastomer or silicone gel) is inactive chemically, and since it excels also in weatherability (chemical resistance) and thermal resistance, it also fits especially implementation of the manufacture approach of the solid model which reproduced the cavity inside this invention.

[0105] The solid model which reproduced the cavity inside this invention In the medical field, by for example, the thing reproducing the configurations of the affected part or the affected part, and its boundary region It is supposed that it is possible medical practitioners not only can to grasp intuitively the three-dimensions configuration and structure of the affected part and affected part circumference correctly, but to actually insert various kinds of medical equipments, such as a catheter and an endoscope, in the cavernous part which reproduced the cavity inside a solid model further, and to use for trial of an operation etc. The solid model which reproduced the blood vessel lumen which has many diseases, such as an aneurysm, and the vasoconstriction section or the thrombus section, as an example of operation trial is used. By inserting a catheter, an aneurysm plug way, a vasodilatation way and a stent placement way, The solid model reproducing the stomach lumen which has many diseases, such as trying operations, such as an artery lock out way, gastric cancer, and an esophagus cancer, an esophageal lumen, or the large intestine lumen which has colon cancer and a polyp of colon is used. It is possible by inserting an endoscope to try the operation to excision, such as cancer and a polyp. Such operation trial can be carried out to various parts, such as a nasal cavity, an ear space, the abdominal cavity, and a uterus.

[0106] Thus, in the medical field, it is very useful as an auxiliary means for raising the result of training sharply in order use for the purpose which grasps a configuration, a condition, etc. of the affected part or its circumference part is possible for the solid model which reproduced the cavity inside this invention and also to carry out smoothly the operation which requires an advanced technique and skill. Moreover, use of the solid model which reproduced the cavity inside this invention can be used in various fields, such as the educational fields, such as the science educational field and the medical indoctrination field, without being limited to the medical field.

EXAMPLE

[Example] Although an example is given and this invention is explained concretely hereafter, this invention is not limited only to these examples and does not need to pass through all the processes indicated on the occasion of actual operation. generation of the data for carrying out laminating molding of the laminating molding model 21 in [the example 1] especially -- Seki -- although the process corresponding to claim 4 is also described the bottom, there is a process which generates the data for carrying out laminating molding of the laminating molding model 21 out of range [a preparation process according to claim 3], and it is not necessary to necessarily carry it out from claim 1

[0108] [Example 1] A photograph was first taken to a patient's head with the X-ray CT scanner with spatial resolving power of 0.35x0.35x0.5mm of a helical scan, medicating the interior of a blood vessel of a photography field with a contrast medium, in order to obtain the three-dimensions data about the configuration of the cerebral blood vessel made into the object of solid modeling, and the **** artery which it reaches and is the affected part. After reconfigurating the three-dimensions data obtained by photography in the 2-dimensional image of 256 gradation which has the resolution of 512x512 of 500 sheets arranged at equal intervals in the direction of a body axis for delivery to three-dimensional-CAD software, they saved the image data corresponding to a 2-dimensional each image to the 5.25 inch magneto-optic disk by the drive built in said X-ray CT scanner in the sequence which is in agreement with bearing of the exposure axis.

[0109] Next, said image data was incorporated to the store inside a computer in the personal computer by

the 5.25 inch light MAG drive which made external connection, and the three dimensions configuration data of the STL format (format which expresses a three dimensions curved surface as an aggregate of a triangle patch) needed for laminating molding were generated from this image data using commercial 3-dimensional CAD software. By carrying out the laminating of the inputted 2-dimensional image in this conversion based on photography spacing By building the scalar field of the three dimensions which make a concentration value scalar quantity, and specifying the specific concentration value which gives a blood vessel internal surface on the scalar field After building the three-dimensions configuration data of a blood vessel lumen as AISO surface (interface of a specific scalar value), the rendering of triangle polygon approximation is performed to the built AISO surface.

[0110] The three-dimensions configuration data of the generated STL format were transmitted to the laminating molding system of a melting resin jet method next, and while determining the arrangement and the direction of a laminating of the model within a molding system, and laminating thickness, the support was added to the model. Thus, the generated data for laminating molding were sliced in laminating molding thickness (13 micrometers) predetermined in a computer top, and much slice data were generated. and the thing to do for the whole surface [every] laminating formation of the resin hardening layer of the assignment thickness which have the configuration which be in agreement with each slice data by fuse with heating the molding ingredient (melting point : dissolve in an acetone easily about 100 degrees) an ingredient used p - toluenesulfonamide and a p - ethylbenzene sulfonamide as a principal component, and spout based on each slice data obtained by do in this way -- laminating molding be performed. By removing a support after formation of the last layer, the laminating molding model of a cerebral blood vessel lumen field was created.

[0111] On the other hand, the dies body used in order to fabricate the external configuration of the solid model 11 was created by machining. The internal shaping side of this dies body is carrying out the cube configuration, and assembly and separation are possible for the member which constitutes a dies body. After having arranged the laminating molding model 21 created by the laminating molding system inside this dies body for cast molding, when both were fixed, the mold was created by pasting up the edge of a model on a dies body inside.

[0112] thus, the liquid silicone elastomer of a 2 liquid hybrid model with the high transparency in which polymerization hardening in a short time by heating is possible inside the created mold -- slushing -- 75-degree C constant temperature -- by heating within a layer for 1 hour, polymerization hardening was carried out and the solid model was formed. And after checking that sufficient hardening had been obtained, sequential separation was carried out and the member which constitutes a dies body was removed.

[0113] thus, the solid model 11 of the acquired cube configuration -- 120-degree C constant temperature -- by heating within a layer for 1 hour, the laminating molding model 21 which exists in the interior of the solid model 11 was fused, and elution was performed to the exterior of the solid model 11. In addition, the edge of the laminating molding model 21 performed this elution from the part exposed from the solid model 11. The whole block was cooled to the room temperature after the elution of the molding ingredient by heating melting, and the acetone was poured into the cavernous section formed in the interior of the solid model 11 of the elution of a laminating molding model. Thereby, the molding ingredient which remained to the solid model 11 interior was dissolved, and the solution-ized molding ingredient was eluted to the exterior of a solid model. Thereby, the laminating molding model 21 was completely removed from the solid model 11 interior, and the solid model which reproduced the cerebral blood vessel lumen inside was obtained.

[0114] the constant temperature again set as 120 degrees C in order to, eliminate the component of said molding ingredient diffused inside the solid model 11 at the time of melting of the laminating molding model 21 more nearly finally than the interior of the solid model 11 -- said solid model 11 was heated within the layer for 1 hour, said component was evaporated, and this removed.

[0115] Thus, the solid model 11 of the produced cerebral blood vessel lumen was that the configuration of the cerebral blood vessel lumen reproduced by the solid model 11 interior, structure, and the configuration of the cerebral aneurysm reproducing the affected part are recognized to be easily and correctly by viewing by

having used the highly transparent silicone elastomer for the molding material by having high transparency and having established the flat surface 14 by making an external configuration into a cube configuration further. Furthermore, the solid model of the produced cerebral blood vessel was what presents the insertion feeling very just like the time of an actual cerebral blood vessel operation, and actuation feeling to insertion of the catheter which is pouring a lubricant into the interior and is a medical device. Drawing 1 and drawing 2 show the laminating molding model of the cerebral blood vessel lumen field produced by the schematic diagram and laminating molding system of a solid model of the cerebral blood vessel lumen finally manufactured by operation of this invention, respectively.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the whole perspective view having shown one gestalt of operation of the solid model which reproduced the cavity inside this invention.

[Drawing 2] It is the whole perspective view having shown one gestalt of operation of the laminating molding model reproducing a cavity produced by laminating molding.

[Drawing 3] It is the important section cross-section expansion perspective view showing the cross-section structure at the time of producing the laminating molding model reproducing the cavity shown in drawing 2 as structure in the air.

[Drawing 4] It is a flow chart explaining the outline of the manufacture approach of the solid model which reproduced the cavity to the interior according to claim 1.

[Drawing 5] It is a flow chart explaining the outline of the manufacture approach of the solid model which reproduced the cavity to the interior according to claim 2.

[Drawing 6] It is a flow chart explaining the outline of the manufacture approach of the solid model which reproduced the cavity to the interior according to claim 3.

[Drawing 7] It is a flow chart explaining the outline of the manufacture approach of the solid model which reproduced the cavity to the interior according to claim 4.

[Drawing 8] It is a flow chart explaining the outline of the manufacture approach of the solid model which reproduced the cavity to the interior according to claim 5.

[Drawing 9] It is a flow chart explaining the outline of the manufacture approach of the solid model which reproduced the cavity to the interior according to claim 6.

[Description of Notations]

11 Solid Model
12 Solid Model Formation Part
13 Cavernous Part
14 Flat Surface
15 Elution Part
21 Laminating Molding Model
31 Non-Laminating Molding Field

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